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COVER: Thoroughfare for Automobiles Lined with *Roystonea regia* in Botanical Garden and Botanical Institute of Caracas, Venezuela. Photo by Julian A. Steyermark.

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Missouri Botanical Garden Bulletin

Vol. XLIX No. 1 January 1961

BOTANICAL GARDEN AND BOTANICAL INSTITUTE OF CARACAS, VENEZUELA

JULIAN A. STEYERMARK

One of the show spots in the glamorous city of Caracas, Venezuela, is, without doubt, the Botanical Garden and Botanical Institute. Started 15 years ago in 1945 by Dr. Tobias Lasser, who has been its able director since the beginning, the Botanical Garden (Jardin Botanico) is part of the great university of Caracas (Universidad Central de Venezuela). It is a large green park comprising 70 hectares (174 acres approximately) nestled along the southern margin of the mountain valley in which Caracas is located. A large part of the Botanical Garden is hilly, occupying the southern slopes of a range of small mountains adjacent to the Caracas valley.

The garden was established for the purpose of growing all the species of plants which can be cultivated in Caracas, including native as well as foreign species. One of the objectives is to grow as many native Venezuelan species as is possible at this altitude (approximately 3000 feet above sea level) and temperature (68.9° F. average). Of approximately 2,500 species of plants in cultivation in the garden, about 70% are native species of Venezuela. Over 200 different species of trees are grown here. The garden is maintained by Mr. Augusto Braun, the chief gardener, who is a well-trained Swiss horticulturist.

The Botanical Garden is laid out in several sections: 1) the Succulent plant collection, which features many plants characteristic of desert or arid regions of Venezuela, other parts of South America, Mexico, and Africa; 2) the Economic plant collection, containing plants grown for their medicinal properties or for their value horticulturally, or in connection with foods, fibers, resins, gums, and latex; 3) the Palmetum, devoted to the culture of nearly 100 species of palms; 4) the Aquatic plant collection, which is grown in a number of pools and small lakes scattered throughout the garden; 5) the Conservatory, housing various kinds of tropical plants demanding humidity, shade, and protection from wind; 6) the Orchidarium, containing a diversified collection of orchids; 7) a Nursery section devoted to the growing of seeds and the reproduction and multiplication of various plants for other parts of the garden; 8) the Tropical Forest section, showing an extensive naturalistic presentation of trees, shrubs, vines, and herbaceous plants as they are ordinarily seen growing in tropical rain forests. This

last section especially is one of the most fascinating in the entire botanical garden. Here one walks along trails in the midst of what seems to be real tropical rain forest, with many kinds of ferns, aroids, palms, Marantaceae *(Colothea, Maranta, Ischnosiphon)*, Zingiberaceae *(Costus, Hedychium)*, Amaryllidaceae *(Curculigo*, species of *Heliconia, Begonia, Pilea, Peperomia*, and various ground covers. The forest canopy is topped by various trees of el miao *(Anacardium rhinocarpus)*, matapalo *(Ficus* spp.*)*, copey *(Clusia* sp.*)*, jabillo *(Hura crepitans)*, bucare *(Erythrina* sp.*)*, and caro *(Enterolobium)*. The effect produced is truly amazing for its realistically natural beauty.

The forested hills rising above the valley of the garden impart a large area of green cover and wild beauty to Caracas, and, together with the adjacent forested park of Los Caobos (the Mahogonies literally, these trees dominating the park) and other parks scattered throughout the city, help to sustain a more healthful and purified atmosphere. These hills have been reforested among the existing large original trees of *Swietenia* (mahogany), *Anacardium, Ficus, Erythrina, Hymenaea, Lonchocarpus, Machaerium*, and *Enterolobium*, and smaller trees and shrubs belonging to the genera *Prockia, Clusia, Erythroxylon, Randia, Rondeletia, Ganzuma, Citharexylum, Trichilia, Bauhinia, Cap-*

Portion of Succulent Collection, showing Cacti, Agave, and Yucca.
PHOTO BY J.A.S.

PHOTO BY J.A.S.

Scene in Tropical Forest Section with Polypodium fern in foreground and Philodendron at right.

paris, *Trema*, *Roupala*, and *Ximenia*. About 150,000 trees have been planted, with an average of 10,000 planted each year. Within twenty years from the time of planting, these trees will have become large enough to effect a true woodland condition. Some of the trees which have been planted include species of *Astronium*, *Clusia*, *Tabebuia*, *Ficus*, *Persea*, *Platymiscium*, *Jacaranda*, *Erythrina*, *Cordia*, *Machaerium*, *Lonchocarpus*, and *Cassia*. These have been planted with the aim of knowing which trees will thrive best on the deforested sections of slopes of the Avila Mountain, which lies along the north side of the valley of Caracas. This is an important project in the botanical garden, since each Minister of Agriculture considers as his pet project the reforestation of the Avila Mountain. Although emphasis is thus placed on reforestation with native subjects, some plantings have been given over to foreign species of *Eucalyptus*, *Casuarina*, and *Cassia siamea*. The section of forested hills described here constitutes the Arboretum, featuring more than 70 different kinds of trees. In the valley section of the garden are also many kinds of trees arranged according to their respective families.

The section of the reforested hills section of the Arboretum is not wa-

tered, since it occupies too large an area. The remainder of the garden, however, is given water regularly during the months of the dry season, most especially from December to mid-April.

The Botanical Institute (Instituto Botanico) is situated within the Botanical Garden. It is under the direction of the Department of Renewable Natural Resources (Recursos Naturales Renovables) of the Ministry of Agriculture (Ministerio de Agricultura y Cria) of Venezuela. Dr. Lasser is also director of the Botanical Institute. The building in which the institute is housed is a beautiful modern structure, in harmony with other parts of the adjacent university. Here are located the herbarium, library, lecture rooms, laboratories, and offices of the staff. The latter consist of Dr. Lasser, Dr. Leandro Aristeguieta, curator of the herbarium and specialist on Compositae and *Heliconia*, Dr. Valkmar Vareschi, ecologist and specialist on ferns and lichens, Dr. Ernesto Foldats, specialist on orchids and marine algae, Dr. Zoraida Luces de Febres, specialist on grasses, and the present author.

Modern fluorescent lighting illuminates the various rooms of the Botanical Institute, and beautifully planted patios give color and gaiety to the surroundings. In one of the patios adjacent to the herbarium and offices there is a pool filled with tropical white and purple ever-blooming water lilies (*Nymphaea*). Their fragrance and color lend constant charm and interest to the beautiful surroundings.

The herbarium (Herbario Nacional de Venezuela) occupies a large air-conditioned room containing numerous modern steel cabinets. Approximately 100,000 herbarium specimens are lodged in these cases, 95% of the specimens originating from Venezuela. The purpose of the herbarium is to bring together and maintain as complete a collection as possible of the Venezuelan flora, which is estimated at least at 20,000 species of vascular plants. Continued exploration of various parts of Venezuela by staff personnel, as well as by botanists from the United States and other countries, is constantly adding genera and species previously unrecorded from Venezuela, as well as numerous species new to science. This is especially true from collections made in the southern half of the republic. Publication of an illustrated flora of Venezuela is being planned and is in actual state of progress. The herbarium, of course, is an indispensable tool for the implementation of such a work.

Dr. Julian A. Steyermark is now with the Botanical Garden and Botanical Institute of Caracas, Venezuela. In cooperation with the New York Botanical Garden he is making a plant collecting expedition into the virgin forest section of Venezuela near the British Guiana border.

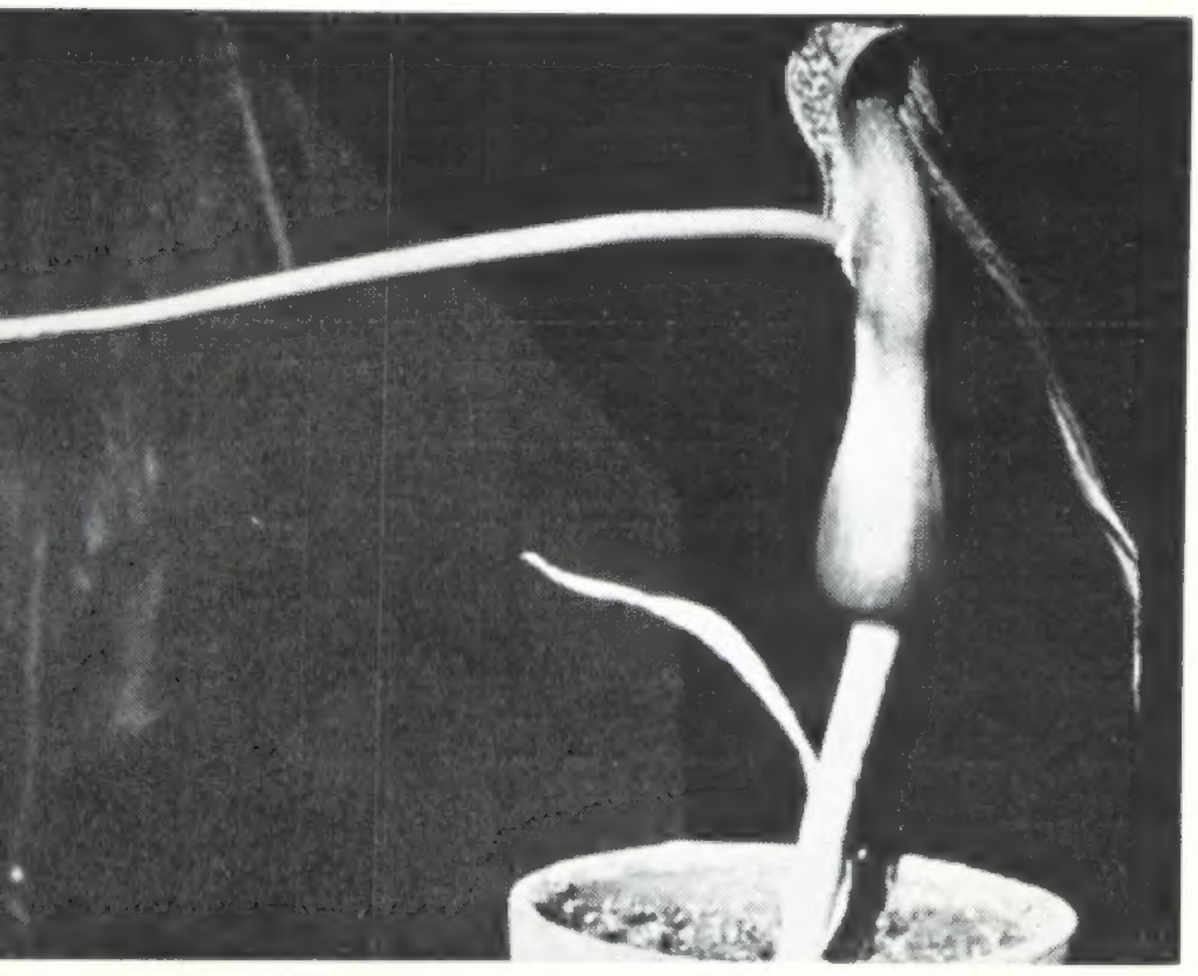
THE VOODOO LILY — DIME-STORE MAGIC

GEORGE S. BUNTING

SUCH A bizarre aroid as *Sauromatum guttatum*[1] deserves greater popularity. Its blossom grows from a bulb-like corm at a remarkable speed; a corm set on a windowsill may, within six weeks, bear an inflorescence such as pictured here. The blossom consists of a spike (spadix) enclosed within a sheath (spathe) that is bronze-olive outside.

As the sheath partially unfurls, the tip of the spadix greatly elongates and bends forward. The part of the spadix just inside the mouth of the spathe bears a zone of yellow male flowers, below which is a long barren area. Near the base of the spadix is a zone of female flowers with a group of much-enlarged sterile flowers just above. As the pollen is shed from the male flowers, the very elongate terminal portion of the spadix begins to emit an odor not very different from that of decaying meat. Needless to say, this feature may have some effect on the popularity of this species, but it should not. This barren part of the spadix should be cut off and discarded at the first suggestion of any odor, and the blossom will be scarcely less fascinating.

An inflorescence of the Voodoo Lily may reach 12″ or more in length before it unfurls to expose the 9″ pencil-like appendage of the spadix.



Handsome coloring on the inside of the spathe is never completely exposed.

Though interesting enough externally, it is the inside of the spathe that is bizarrely colored—purple-spotted on a background of yellow that becomes white in the tube, the basal part a rich velvety purple. The coloring of the

The mottled leaf stalk elongates rapidly as the inflorescence fades, but the divided leaf blade unrolls slowly.

spathe and the odor emitted by the spadix closely imitate that of aging meat. This is an excellent example of mimicry in plants—an adaptation that, in its native habitats in southeastern Asia, attracts carrion-loving insects. In crawling over the flowers, these insects transfer pollen from the male flowers of one plant to the female flowers of another, thus bringing about the pollination necessary for seed production.

For the sake of one blossom, it is unnecessary to pot the corm in soil, but it is recommended. If planted, watering should be held to a minimum for several weeks until growth commences. As the blossom fades and the single leaf begins to appear, watering may be more frequent. The large leaf is umbrella-like, divided into 9–11 segments in a vigorous specimen, and borne on a brown-mottled stalk to three feet long. To maintain the same corm for growth in subsequent years, the leaf must be permitted to grow to maturity. The plant should be treated like other growing plants. Finally, the leaf will die down, and a rest period ensues, during which less watering is required. A well-established bulb may begin to push up a new blossom in mid-November and flower by Christmas.

When mature, the much-divided leaf may be two feet across.

Indoors, plant several corms of the Voodoo Lily in one pot. The effect will be better, especially when the leaves appear. If planted in the garden rather deep, and mulched heavily in winter, *Sauromatum* will probably over-winter out-of-doors. A closely-related species, *Arum italicum*,[1] is reliably hardy in the St. Louis area.

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[1] Sometimes this species is erroneously called *Arum cornutum*.

MISSOURI BOTANICAL GARDEN
1961
EDUCATIONAL PROGRAMS

ACTIVITIES FOR CHILDREN

A SUMMER Nature Program made possible by a grant from the Pitzman Foundation is offered for children ages 7 to 17. Children have a fundamental curiosity about everything going on around them and these summer courses given by the Garden encourage this interest in living things and answer many questions that arise from a closer contact with nature.

Registration for the first session will be June 19th and for the second session July 24th. Further information about the courses and registration will be available at the Main Gate after May 1st, telephone PRospect 6-1785.

Free Nature Programs for children, ages seven and over, are held every Saturday morning from 10:00 A. M. to 11:30 A. M. in the old Museum Building (enter at Cleveland Avenue gate) or elsewhere as may be announced.

For further information call PRospect 6-5567

A Group of Children in Rapt Attention as Mr. Kenneth Peck Instructs Them in How to Identify Kinds of Trees by Their Leaves. PHOTO BY GLOBE DEMOCRAT

Program for Saturday Activities for 1961

A. First Six Months—January through June

January
- 7 Dead or Alive
- 14 Winter Puzzles
- 21 Do You Have a Green Thumb?
- 28 Jungle Plants

February
- 4 The Mystery of the Orchid
- 11 The Green Thumb at Work
- 18 Color Sound Movies
- 25 Plants in a Capsule

March
- 4 Three Cheers for the Green Thumb (you may take your plants home)
- 11 The Life Secret of a Plant
- 18 The Story of the Pincushion Forests
- 25 Make Your Own Dwarf Garden (bring your own container)

April
- 1 Sowing Seed for Your Garden
- 8 Flower Shapes and Names
- 15 Hunting for Hidden Flowers
- 22 Spring Safari
- 29 More About Your Garden Seeds

May
- 6 Plants from Historic Times
- 13 Planting Your Garden
- 20 Color Sound Movies
- 27 Plants with Wet Feet

June
- 3 What Is a Tree?
- 10 Exploring the Underworld
- 17 The Queen of Flowers
- 24 Shades of the Night

B. Second Six Months—July through December

July
- 1 Color Sound Movies
- 8 The Grasses
- 15 Life in the Desert
- 22 Algae, Food of the Future
- 29 The New Generation

August
- 5 Color Sound Movies
- 12 Dangerous Plants
- 19 Table Top Greenhouse
- 26 Gardening through the Ages

September
- 2 Plants for the House
- 9 Hundred in one Flower
- 16 Color Sound Movies
- 23 The Devils Footstools
- 30 From Dust to Seed

October
- 7 Fall's Carnival
- 14 Fall's Frolic
- 21 Planting Bulbs
- 28 Witches Brew

November
- 4 Color Sound Movies
- 11 The Rise of Forests
- 18 Woodlands of America I
- 25 Woodlands of America II

December
- 2 Insectivorous Plants
- 9 Make Your Own Christmas Decorations
- 16 Make Your Own Christmas Decorations
- 29 Color Sound Movies

COURSES FOR ADULTS IN HOME GARDENING AND BOTANY

The Garden is offering a series of courses for the Home Gardener and a similar series for those interested in Botany. The courses may be taken as independent units. However, anyone satisfactorily completing the two basic courses and eight additional courses, six of which are in the major subject, are eligible to receive a Certificate of Achievement.

The courses will be open to all interested persons. The fees charged for the adult courses include all materials. The field trips will be arranged by consultation with the groups concerned. Most classes and practice sessions will be held in the classroom and greenhouses of the Garden's Experimental Greenhouses which can be reached by entering the Cleveland and Tower Grove Avenue gate.

Registration for all courses must be made in advance as the number of persons who can be accepted for a given course is limited. Should interest warrant, second sessions will be considered. Should less than twenty persons register for any course, it may be dropped in which case the fees will be refunded.

All courses will be taught by Garden Staff members and by selected specialists. Fees based on amount of time and materials supplied by the Garden.

A. Home Gardening

101. Home Garden Preview *Basic Course*
For the home owner, a non-technical basic course including facts and procedures for planning, planting, pruning, fertilizing, watering and general maintenance of home grounds.

102. Plants for Your Garden *Basic Course*
Introduction to cultivated plants for particular places and uses. How to identify and recognize them by actual study of material in the laboratory and in the field.

103. Garden Planning and Design. To be given in 1962.

104. How to Propagate from Seed.
Fundamental facts and procedures for producing annuals, biennials and some perennials from seed for use in your garden. The Garden supplies seed, germinating media and soil for four metal flats of seedlings which you may take home. Persons wishing to supply their own seed must bring it to the first session.

105. How to Propagate from Cuttings.
Fundamental facts and procedures of producing trees, shrubs and perennials from cuttings (asexual reproduction). The Garden will supply one plastic covered metal propagating flat, media and plant materials for 40 to 50 kinds of plants.

106. Home Food Garden.
General instruction in the facts and procedures for preparation and maintenance of a home food garden. Plant selection, control of weeds, pests and other problems confronting the home gardener. Attention to individual problems will be given.

107. Bulbs Indoor–Outdoor.
Instruction on bulb forcing and outdoor bulb culture will be given. The Garden will supply each student with 24 top quality bulbs in 7 inch clay pans which may be taken home. The Garden will also provide space for cool treatment which the forced bulbs require.

108. House Plants.
General instruction in the kinds of house plants, care and growing requirements such as heat, light, water and fertilizer will be given. Attention will be given to individual home problems.

109. Preparation and Care of Lawns.
General instruction concerning the preparation, care and maintenance of lawns. Special attention will be given to individual problems.

110. Home Orchid Culture.
Orchids suitable for home culture and best ways of growing them. Potting demonstration and practice. Students may take the plant they pot home.

111. Plants under Artificial Light. To be given in 1962.

112. Area Management. (For persons with small acreages or estates).
Practical instruction on erosion control, weed and brush control and basic management of ponds. Specialized instruction in management of meadows, marshes and forests will be explained, emphasizing recreation and wildlife.

B. Botany

201. Botany for Beginners. *Basic*
General instruction in botany. A semi-technical course to give the amateur an understanding of the plant world.

202. Plant Materials. *Basic*
General instruction to enable the student to identify and recognize many forms of plant life. Students will work with living material in the laboratory. One session will be a field trip.

203. Ecology. To be given in 1962.

204 & 205. Field Botany.
Field courses are designed to enable the student to recognize common wild flowers and weeds in the field in the Spring and in the Fall, and to understand plants' relationship with their environment.

206. Economic Botany.
General instruction in useful plants and their relation to man are studied, using the Garden's extensive collections of materials from archeological sites, primitive culture and modern breeding experiments.

207. Mosses (A) and Ferns (B).
General instruction in mosses and ferns. Participants will learn how to identify and to recognize the

common kinds. Two sessions will be field trips.

208. Genetics. To be given in 1962.

209. Survey of Grasses.
The student will learn how to identify and to recognize the common grasses of fields and lawns.

210. Survey of Orchids.
The student will learn how to identify the many unusual and common orchids, using the Garden's large collections.

211. Plant Physiology. To be given in 1962.

212. Paleobotany. To be given in 1962.

SCHEDULE OF COURSES IN HOME GARDENING

o.	Title	Number of Sessions	Fee	Day of the Week	Date of the Month	Time of the Day
1	Home Garden Preview, *Basic*	8	$10.00	Tues.	Jan. 10 to Feb. 28	8:00 to 9:30 P. M
2	Plants for Your Garden, *Basic*	8	$10.00	Tues.	Apr. 25 to June 6	8:00 to 9:30 P. M
					(One session is a field trip to be arranged.)	
3	Garden Planning and Design	To be given in 1962				
4	How to Propagate from Seed	5	$12.00	Tues.	Mar. 14 and 21 Apr. 4, 11 and 18	1:00 to 2:30 P. M
				Thurs.	Mar. 16 and 23 Apr. 6, 13 and 20	8:00 to 9:30 P. M
5	How to Propagate from Cuttings	5	$12.00	Tues.	Oct. 17 to Nov. 14	1:00 to 2:30 P. M
				Thurs.	Oct. 19 to Nov. 16	8:00 to 9:30 P. M
6	Home Food Garden	3	$ 6.00	Thurs.	Apr. 20, May 4 and 11	8:00 to 9:30 P. M
7	Bulbs, Indoor–Outdoor	2	$ 8.00	Tues.	Oct. 3 and 10	1:00 to 2:30 P. M
				Thurs.	Oct. 5 and 12	8:00 to 9:30 P. M
8	House Plants	3	$ 6.00	Thurs.	Oct. 5, 19 and 26	8:00 to 9:30 P. M
9	Preparation and Care of Lawns	3	$ 6.00	Tues.	Aug. 8, 15 and 22	7:00 to 9:00 P. M
0	Home Orchid Culture	1	$10.00	Sat.	April 8	10:00 to 3:00 P.
1	Plants Under Artificial Light	To be given in 1962				
2	Area Management	4	$ 8.00	Wed.	Feb. 1 to 22	8:00 to 9:30 P. M

SCHEDULE OF COURSES IN BOTANY

o.	Title	Number of Sessions	Fee	Day of the Week	Date of the Month	Time of the Day
1	Botany for Beginners, *Basic*	8	$10.00	Thurs.	Jan. 5 to Feb. 23	8:00 to 9:30 P. M
2	Plant Materials, *Basic*	8	$10.00	Tues.	Apr. 25 to June 6	8:00 to 9:30 P. M
					(One session is a field trip to be arranged.)	
3	Ecology	To be given in 1962				
4	Field Botany—Spring	3	$ 6.00	Sat.	May 20, 27 and June 3	Start from Garde 10:00 A. M.
5	Field Botany—Fall	3	$ 6.00	Sat.	Sept. 23, 30 and Oct. 7	Start from Garde 10:00 A. M.
6	Economic Botany	5	$10.00	Wed.	Mar. 15 and 22, Apr. 5, 12 and 19	8:00 to 9:30 P. M
7	Mosses and Ferns	5	$10.00	Wed.	Oct. 4, 11, 18 and 25, Nov. 1	8:00 to 9:30 P. M
8	Genetics	To be given in 1962				
9	Survey of Grasses	3	$ 6.00	Thurs.	Aug. 10, 17 and 24	7:00 to 9:00 P. M
0	Survey of Orchids	5	$10.00	Wed.	Apr. 12, 19 and 26, May 3 and 10	8:00 to 9:30 P. M
1	Plant Physiology	To be given in 1962				
2	Paleobotany	To be given in 1962				

COOPERATION, A FACTOR IN PLANT INTERACTIONS

LILLIAN OVERLAND

SCIENCE, because of the great complexity of life, is constantly faced with the pitfall of erroneously explaining any major process, either due to over emphasis of any one aspect, regardless of its individual validity, or through ignorance of equally important ones.

Such is probably the case with the role of "struggle for existence" in evolution. Strangely enough, it was not Darwin himself who was directly responsible for this situation. For although he sought to explain evolution on the basis of natural selection operating through competition and struggle, he was aware that other important factors were involved, and warned that the term "struggle for existence" must be used in a large and metaphorical sense to include dependence. Perhaps the social and economic situation of the day had a decisive influence in the matter, for during the turbulent time of the Industrial Revolution, when much doubt as to the wisdom of the drastic changes must have existed, Darwin's theory seemed to provide a natural justification of human struggle and cupidity based on the "red claw" concept of nature. Superficially it was possible to provide much apparently supporting evidence, and thinking, for the most part, became channeled in this direction. Thus, although competition doubtlessly exists, the failure to recognize other equally, if not more important, aspects, resulted in a false overall picture of natural selection. This no doubt set back scientific progress considerably.

Lost, however, among the general opinions of the day were forerunners of other ideas. Despite his belief that plants in a given area are in a constant state of war, de Candolle, in 1820, observed that when conditions favor a large number of species to the same degree, plants will live together in a mixed community. Although he could not explain why this is so, it clearly indicated that there must be other forces than competition in operation, or the result would be one dominant species. Nägeli later confirmed this. He found that no matter how strong the competition is, plants, as a rule, do not suppress each other to the degree that one alone persists in the habitat where it is stronger, but on the contrary, they tolerate each other in the same situation and competition operates reciprocally upon the number of individuals, and then only between similar plants which are under similar conditions. Competition, therefore, cannot be regarded as an active struggle, nor the sole force; interdependence and cooperation are of necessity implied.

This idea was further expanded by other scientists such as Macmillan and Clements, who compared the flora of a region with the condition of mutual interdependence and competition in human society. The comparison between plant and animal, including human communities, is valid insofar as all have mutual dependence and reciprocal influences among many types of individuals, giving rise to organized division of labor with all

working for the benefit of the whole community. A community, thus, is not a mere grouping, but the result of interaction of plants and of numerous interdependent factors, one of which is competition.

As Darwin had earlier indicated, Clements, in 1905, actually confirmed from detailed competition studies, that "struggle for existence," except in such organisms as parasites, is true only in a figurative sense. With adequate water, nutrients, and light, he found that competition ceases and starts again only when one factor is limited. It then occurs mostly between like species with similar needs and never results in the elimination of all associated species. The idea of aggressive struggle and mechanical competition, in view of this, must be seriously questioned.

In a broad sense, perhaps the most obvious evidence is found in the mere coexistence of such a wide range of species. Were the theory of natural selection by survival of the fittest correct, literally, then we would expect only a very few highly specialized forms to have survived. Lower plants such as algae, mosses, and ferns, should either have been completely eliminated by now or should be on the way out. No such evidence exists. On the contrary, we find a complete range from lowest to highest plants as well as animals living side by side in apparent harmony. It is also interesting to note that the most highly developed group of plants, the Compositae, represent an advanced form of cooperation by having a multiple flower enclosed within one corolla.

The animal kingdom similarly reveals the importance of cooperation. In his remarkable book, "Mutual Aid, a Factor of Evolution," Kropotkin, in 1902, concluded:

> "We may safely say that mutual aid is as much a law of animal life as mutual struggle but that as a factor of evolution it most probably has a far greater importance inasmuch as it favors the development of such habits and characters as insure the maintenance and further development of the species together with the greatest amount of welfare and enjoyment of life for the individual, with the least waste of energy."

Since cooperation is, thus, at least as important or probably more so than competition in the operation of natural selection, he felt that the elimination of the latter created better conditions.

In support of this view is the fact that since Darwin's time there has been no actual evidence to show that the "extinguisher" is the fittest. On the contrary, anthropologists such as Ashley Montagu have presented numerous examples from the highest animal, man, to support the idea that mutual aid and cooperation are the dominant principles of life, and that cooperative processes, though not the only ones, are characteristic of all living beings.

Although it cannot be put to a scientific test, perhaps man's intuition provides some of the best supporting evidence. For, as an intelligent being produced by evolution, it is not improbable that within the depths of his mind are vestiges of the past as well as indications of the future. He alone of all animals can measure his natural success, or compliance with the laws

of nature, in terms of peace or happiness, and intuitively he recognizes the law of cooperation. Although it might be violently argued that egotism and competition are often the greatest driving forces of life, the acid test seems to lie in the fact that basically it is harmony and cooperation which provides man's deepest satisfaction and truest human progress. These drives start at birth; from the state of a helpless infant which must be protected and cared for, man develops into a gregarious social animal who can find true fulfillment only through interaction with his fellow man. If this is any indication of natural law then it may be implied that cooperation is a stronger force and perhaps an indication of future development, whereas much of competition might be regarded as a primitive characteristic. By the same token, war may be regarded as an aberration with no biological support. For it was only through cooperation that, regardless of relative physical weakness, a highly complex being was able to evolve from a simpler one. Or, as stated by the philosopher, Bergson:

> "The real facts of evolution were to be found, not in a mechanical elimination of the unfit, but in the creative surge of life . . . "

In 1944 a group of American biologists summed up the principle as follows:

> "The probability of survival of living things increases with the degree in which they harmoniously adjust themselves to each other and to their environment. Natural selection favors cooperation. We begin to understand then that the process of evolution is one which favors cooperating rather than disoperating groups and that "fitness" is a function of the group as a whole rather than separate individuals. The more cooperative the group the greater is the fitness for survival which extends to all its members."

The habit of thinking in terms of "struggle for existence" and ruthless condemnation of the weakest is not only incorrect, but has done much harm. For because of the overemphasis, very little effort has been made to elucidate other factors, with the result that the field is largely unexplored. What information does exist is scanty and often contradictory. The time is ripe, therefore, to start looking seriously for the mechanisms which might explain plant interactions, and especially the role of cooperation. It is to this end that a large part of the research at the Garden will be directed.

Plant Interactions

To date, most work on plant interactions has dealt chiefly with the more obvious factors of water, nutrient, temperature, light, etc. Although much more remains to be learned about each of these, a final understanding can come only through the correlation of all possible factors. Consequently, it is of equal importance to investigate relatively little understood or unsuspected ones.

Among the latter class is the highly controversial question of plant secretions. For a long time it was disputed as to whether or not normal plants excreted substances which could be absorbed by others, thereby exerting an influence on them. Today, although still far from complete, we have sufficient evidence to believe that

this is so. Experiments have demonstrated that roots are able to absorb not only inorganic substances but also relatively large organic molecules and consequently it is possible for neighboring plants to influence each other's chemical composition through mutual secretions. Even very small quantities which are difficult to measure may play an important role, as shown by the great effect of very small amounts of plant hormones.

Influenced perhaps by the concept of competition, it is not surprising that early ideas and investigations in this field were concerned with inhibitory secretions. Although they supply most of our present evidence for plant secretions, as we shall see later, there is another side.

De Candolle's theory of Antagonism stated that all plants excrete toxic substances which stay in the soil for a long time and are especially effective on the same species. More recent work by Schreiner has confirmed that soils of reduced fertility do contain toxic substances such as picolonic acid, salicylaldehyde, vanillin, and others, and may account for "soil fatigue." Crop rotation, therefore, is based at least partly on root secretions.

Some of the most decisive evidence for plant secretions came from studies by Went and Bonner of typical desert shrubs such as *Encelia* and *Artemisia*, which occur widely spaced with no plants growing beneath them. They showed that this is a result of toxic substances contained in their leaves, which when washed to the ground by rain, inhibit seedlings. They were able to extract and partly identify, chemically, the responsible substances. Similarly, water extracts of a rubber plant (Guayule) which also inhibits seedlings growing beneath it, were found to contain toxic substances.

Other experiments in which water extracts were used, support the above evidence that plant secretions may play an important role. Among such cases are the following:

Grasses are known to affect fruit trees. When water was passed through living roots of grass and then applied to apple trees, a definite inhibition of growth occurred. Similarly, extracts of quack grass *(Agropyron repens)* inhibited alfalfa and wheat.

A substance, juglan, one which can be removed by water from black walnut tree roots, causes inhibition to other plants such as tomato and alfalfa, thus partly explaining the general toxic effects of this tree.

Peach trees, which are difficult to reestablish in old orchards, also yielded a root secretion which was toxic to its own seedlings.

Many cereals have long been known to have a protective mechanism against common weeds. The most effective of these, such as barley, wheat, rye, oats, and flax, are called "Smother Crops," a name based on the idea that they operate mainly through smothering effects of extensive roots and leaves. However, recent experiments carried out here have indicated that there must be other factors. When grown together with adequate nutrient, water, etc., thus eliminating competition, barley still suppressed both chickweed and tobacco. When planted above chickweed, the effect of

barley was much greater than when it was below, thus showing that something must be carried down with rain water from the barley to the chickweed, which inhibits it. Furthermore, water extracts of barley seeds and roots inhibited the germination of chickweed to a large extent but hardly affected tobacco. On the other hand, it has been found by others that extracts of sprouted barley seeds have a beneficial effect on the growth of sugar beet. All this implies that we are dealing with a secretion which is capable of acting very differently on different plants and at different stages of their development. This leads to another very important side of the question of secretions.

Although scientific research is theoretically supposed to be objective, it is clear that only when one looks shall one find, and if one looks only in one direction, one will find only what lies therein. Thus, in the case of root secretions, which may now safely be assumed to play a role of greater or lesser importance in plant interactions, mainly those of toxicity or inhibition have been studied. This occurred despite the long known facts pointing to beneficial relationships.

For instance, farmers have long known and profited from the fact that certain crops do much better when planted with others. Examples are early potato with late cabbage, potato with tomato, tomato with bush bean, bush bean with celery, carrots with peas, and wheat with corn. Also, certain forest trees are known to be especially compatible, such as birch with ash, ash with beech, pine with alder. Many seedlings do best when planted together with others, such as pine with linden, oak with willow, and beech with spruce.

Evidently no one has ever seriously tried to find the reasons for the above relationships. Possible explanations in such terms as mechanical support, reduction of disease carrying microorganisms, etc., have been proposed but never proved. It remains to test some of these known cases under controlled conditions in order to arrive at the answer. It cannot be presumed, of course, that secretions are involved here, but in view of the knowledge of inhibiting ones, it is not unreasonable to predict that possibly beneficial ones might also exist, and consequently should be looked for.

Such evidence is not entirely lacking. For instance, the liberation of significant quantities of nutrient elements in normal root metabolism is known to be widespread. After flowering, there is a normal elimination of inorganic salts, especially phosphorus from legumes and root crops. Roots of legumes are able to dissolve and absorb highly insoluble phosphorus compounds, followed by the excretion of phosphorus salts which can then be absorbed by less vigorous feeders. Also, roots secrete sugar and malic acid, both important in normal mineral nutrition. The exact function of such secretions in plant communities remains to be determined.

Among the most interesting and concrete known cases of beneficial secretions is that of the parasite, *Striga*, which grows on roots of other plants such as soy beans, and cannot germi-

nate unless a host root secretion is present. It has been found that, to a certain extent, this substance may be replaced by the chemical, allyl thiourea. Here then is an unusual case of obligatory cooperation. What other functions, if any, the host root secretion serves, is now known.

Still of greater surprise perhaps are cases of weeds known to have favorable effects on crops, for example *Sisimbrium officinalis* on oats.

We begin to see, therefore, that there are two sides to the problem. The whole phenomenon of symbiosis, or the co-existence of two or more organisms to the mutual benefit of each which has previously been studied mainly with respect to lower plants, might well apply to higher plant interactions as well.

Because of the incomplete state of current knowledge, it cannot be said to what extent secretions, beneficial or harmful, actually play a role in nature. Many coexisting factors such as soil microorganisms capable of converting excreted substances from one form to another, must be taken into consideration. Other evidence indicates that there is no sharp line of demarkation between harmful and beneficial excretions. Concentration alone may make the difference, as is the case with quack grass where extracts of roots in low concentration stimulate rape and oats, but in high concentration greatly retard them. Or, the stage of development may influence the effect. For example, wheat is stimulated by rye in its early growth stages, but is inhibited after flowering; the effect of wheat on rye is the reverse. Experiments employing appropriate extracts showed that the change is due to mutually absorbed substances secreted by both species.

From the foregoing it is clear that much more research is called for in order to solve the general problem of the role of plant secretions. Since in nature there are too many uncontrollable factors, it is essential to carry out many experiments under controlled conditions. After confirming the existence of and studying the biological action of secretions, the next step is to identify chemically the active substances. Finally, and most difficult, is the fitting of this factor into its perspective role in nature, for the final explanation of plant interactions and their function in evolution can come only from an understanding of the balance of the many interacting factors. To this end, the cooperation of many specialists such as the botanist, biochemist, and ecologist is required.

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SOME FACTS ABOUT SHAW'S GARDEN

The Missouri Botanical (Shaw's) Garden was established in 1859 by Henry Shaw, a St. Louis businessman, to be controlled by a Board of Trustees for the public benefit. The Garden is a non-profit institution which receives no support from the city or state, depending on the income from the Shaw estate supplemented by contributions from the public.

The old stone walls and cast-iron fences, the Linnean House, the Museum Building, the part of the Administration Building which was Shaw's Town House, relocated in the Garden in 1890, and the Tower Grove House, his country home, all date from Mr. Shaw's time. The Main Gate, display and growing greenhouses and most other facilities date from the period immediately following the turn of the century. The Climatron, opened in 1960, is the first of several new buildings planned for the Garden's redevelopment. It is the world's first geodesic dome, fully climate-controlled greenhouse and contains the Garden's tropical collections.

The Garden — 70 acres — is open every day of the year (except Christmas and New Year) from 9 A.M. until sundown, and the greenhouses close at 5 P.M. Tower Grove House is open daily from 1 P. M. to 4 P. M. (December to March on weekends only). The Display House presents four seasonal displays:— November, Chrysanthemums; December, Poinsettias; February, Orchids; Spring, Lilies and other flowers. During the year are other shows, competitions and festivals sponsored by various Garden Clubs and Flower Societies.

Courses in Botany and Horticulture for adults are conducted by the Garden staff. Children's nature studies are provided each Saturday of the year and a special nature program is held during the summer. Information on these activities is published in the BULLETIN or may be had by mail or phone. The Garden maintains a research program through the Henry Shaw School of Botany, Washington University.

In 1926 an Arboretum — 1600 acres — was established at Gray Summit, Missouri. Foot trails and roads pass through the Arboretum and are open to visitors in April and May.

The Garden Administration Building is located at 2315 Tower Grove Ave., and the Garden main entrance is at Tower Grove and Flora Place. The entrance at Tower Grove and Cleveland Avenue is also open to the public. The Garden is served by both the Sarah (No. 42) and the Park-Southampton (No. 80) city bus lines.

Persons interested in helping to support the Garden and taking part in Garden activities are urged to do so through the "Friends of the Garden". Information may be obtained from the Main Gate or by mail or phone.

MISSOURI BOTANICAL GARDEN

Bulletin

February 1961
Volume XLIX
Number 2

COVER: *Cypripedium* hybrid "Cyclops"

The annual Orchid Show (January 22 to February 26) is now on display. The Garden is featuring its extensive Cymbidium collection. These plants are in prime condition and help make this one of the finest displays the Garden has shown in many years.

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HOW LENGTH OF NIGHT REGULATES FLOWERING AND FRUITING OF MANY PLANTS

F. W. WENT

Like so many botanists, Garner and Allard were puzzled by how plants could tell the seasons even when they were grown in a greenhouse and kept warm all winter. Some plants, notably a giant race of tobacco called Maryland Mammoth, never flowered during spring, summer, or early fall. Only in the middle of winter were flowers produced, regardless of the temperature of the green house. This was most inconvenient since Maryland Mammoth was desired for hybridizing with ordinary commercial varieties, but this was prevented by difference in flowering seasons. Innumerable experiments including shading, planting in different soils, and feeding with various combinations of nutrients all failed to alter flowering time. Finally Garner and Allard decided to shorten the daily period during which the tobacco was exposed to light. Every afternoon at 4 o'clock some plants were covered with a black box, which was removed next morning at 9 A. M. Promptly the covered plants started to flower, in the middle of summer, whereas the control plants, exposed to the full length of summer days, remained vegetative. This result was so startling and clear-cut that during the next year a study was made of the response of a large number of plants to the length of the light period to which they were exposed daily. This cycle was called photoperiod.

Further experiments were carried on with enthusiasm. In only a few years they resulted in a rather complete understanding of how plants have a sense of time, and how they are able to tell the seasons, regardless of unusually cold or warm springs or summers.

Short Days For Flowering

A number of plants flower *only* when the number of hours of daylight is reduced below a certain minimum, ordinarily about 12 hours. Such plants, requiring short photoperiods for flowering, are called short-day plants. Chrysanthemum, Aster, Cosmos, and Mexican sunflower belong to this group, which includes the majority of our autumn flowers.

Long Days For Flowering

Summer-flowering plants such as larkspur, flax, evening primrose, poppy, Clarkia, Nigella, and Rudbeckia are long-day plants. In other words, they flower *only* when they get *more* than a minimum number of hours of daylight. In winter they will flower in greenhouses only when additional

light is supplied, lengthening the normal winter day to a summer day.

Since the exact length of photoperiod necessary for flowering varies from plant to plant, they bloom at different times of the year. The long-day plants come into flower at some time after the days are lengthening; the short-day plants flower later in summer and in fall, when the days are shortening again.

Fixed Dates

In many plants, temperature has no influence on their photoperiodic response; they start flowering each year at exactly the same time. Such dated flowering makes it possible to set the date of flower shows months or even years in advance. The royal Chrysanthemums, the mainstays of most fall flower shows, set their flowering date by the length of day, or in other words, by the declination of the sun, irrespective of whether the preceding summer and early fall were exceptionally warm or cool. They follow the position of the sun in the sky.

Day-Neutral

Everyone is, of course, interested in what photoperiodicity means for the vegetable in his kitchen garden. Fortunately many vegetables are day-neutral, or, in other words, the length of day has nothing to do with their flowering. They may flower at any time of the year. As examples, potatoes, tomatoes, turnips, Savoy cabbage, and summer lettuce can be mentioned. In the case of summer lettuce varieties, flowering (or "bolting") is caused by high night temperatures (above 65–70°), so that they can be grown anywhere in a moderately cool climate without bolting in summer. Provided the night temperatures are within the right limits, tomatoes will set fruit throughout the year, for flowers are formed equally well in summer and in winter.

Long-Day Vegetables

Many of the leafy vegetables, however, are long-day plants, and start to flower in summer, thus ending their usefulness. Spinach and spring lettuce varieties are notorious in this respect. Many a gardener has become amazed at these vegetables which went to seed before he had time to harvest them. By sowing them very early in the season, a good crop can be obtained, for, during fall, winter, and early spring, the days are short enough to prevent flowering.

Vegetables which are grown for their seeds, such as peas, many beans, and most cereal grains, are long-day plants and should be grown during spring or summer for best results.

Short-Day Vegetables

Finally some short-day plants among the vegetables should be mentioned. Soybeans and some corn varieties, for example, grow vegetatively during early summer, and start to flower some time later. It does no good to sow soybeans much earlier in the spring; later-planted ones will flower and fruit at the same time.

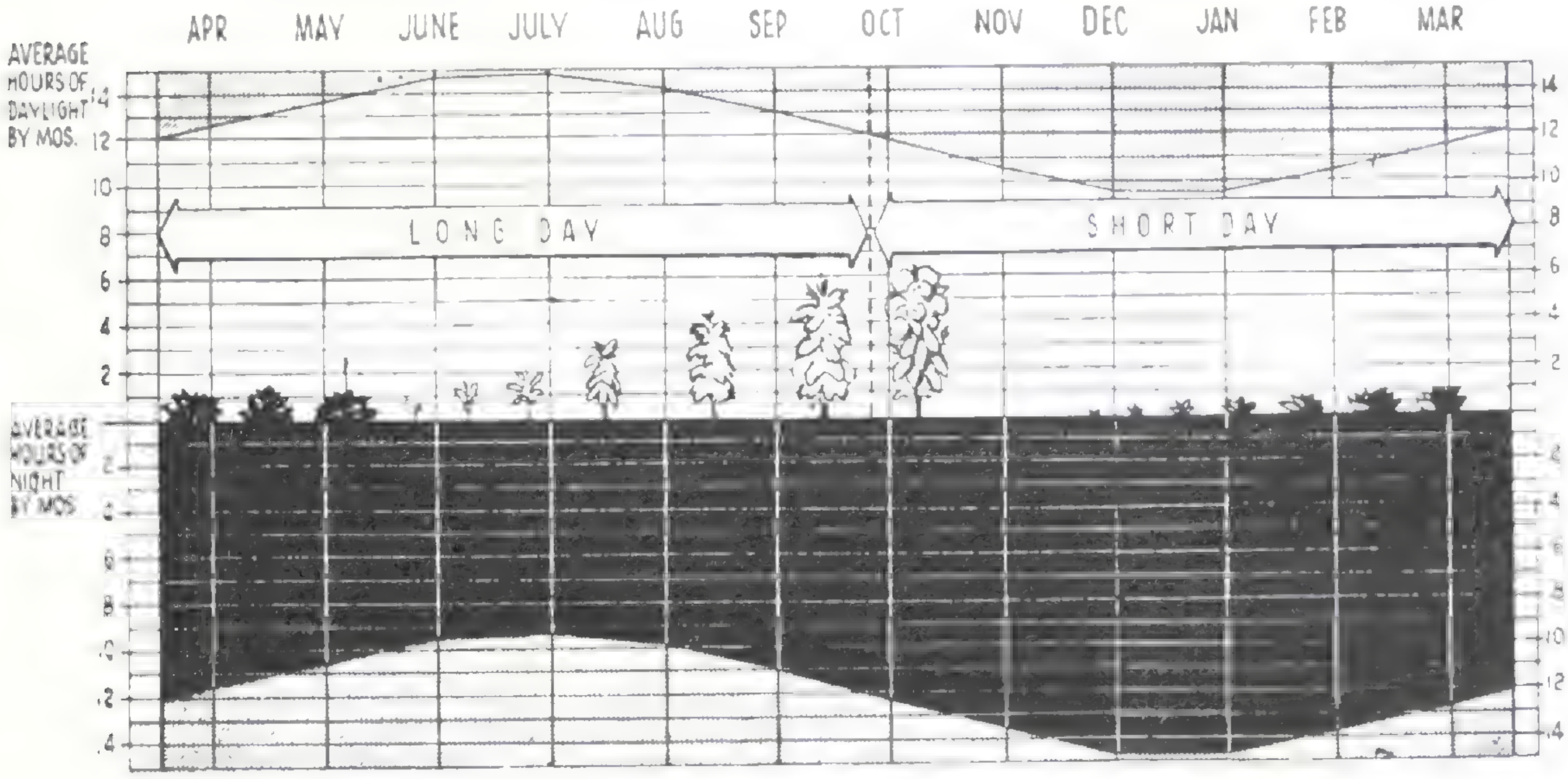
This all sounds very simple. But whereas the principles along which nature works are simple, nature often employs so many principles at the same time, that the results seem hopelessly complicated. In the previous

disussion, only those cases have been mentioned where photoperiodicity was so predominant in causing flowering that the complexity did not appear. But many plants can tell the time of year only by a combination of night temperature and length of day. Take the case of Poinsettia. When the temperature is too high (70°) it does not flower at all, neither in long nor in short days. Therefore, Poinsettias cannot be grown in the lowlands of the tropics. At medium temperatures (60–65°) it is a short-day plant, which corresponds to what we observe; it flowers around Christmas. But if the temperature is still lower (55°), poinsettia flowers even in long days.

Night Is The Regulator

Ever since Garner and Allard did their first experiments 25 years ago, we have been talking about long- and short-day plants, without knowing whether the day length or the length of night was the important factor. Since we knew that light was essential for growth, we just assumed that it was the day which regulated the flowering. But experiments carried out to test this gave most unexpected results. By growing plants in artificial light, it was possible to give a long-day (light) treatment in combination with a long night. Under these conditions only short-day plants flowered, that is to say, short-day plants should rightly be called long-night plants. The companion experiment showed that long-day plants actually responded only to the short nights, for they flowered in the combination of short day and short night. Under those conditions, the short-day plants did not flower. A still clearer proof was provided by giving short-day plants five minutes of light during the middle of the night. Then they had a short day in addition to two short nights, separated by a light period of five minutes. Thus they

Many plants are set like alarm clocks. Spinach continues leaf growth until day reaches length of 12 hours or more and signals that it is time to produce seed. The Chrysanthemum will not bloom until days shorter than 12 hours give the signal.



did not flower. Therefore the work on photoperiodicity points to the importance of the night period for plant growth. This same conclusion was reached in the experiments on growing plants in different temperatures: growth and fruiting were profoundly affected by the temperature during the night. To summarize: many plants can tell the time of year by the length of night. Their flowering and growth are dated by the nights being shorter or longer than a critical number of hours.

Practical Use

Growers are now developing varieties to meet photoperiodicity. Planting dates are based on the night-day length. In northern countries the winter days are so short that strawberries seldom flower and set fruit before March. Eight hours of additional neon light, given after midnight when electric current rates are lowest, give a good strawberry crop. During winter, prices for fresh strawberries are so high that a good profit can be made even after deducting the costs of installation of the lights and of electric current. In the same way Cinerarias, Gloxinias, and other plants, ordinarily not flowering in the middle of winter, can be grown commercially and offered for sale blooming at any time.

TRUE CEDARS

JAMES A. DUKE

There is little greenery left in the Ozarks. The drab of winter is firmly entrenched; brown is the dominant color of the trees, naked save for a few straggling withered leaves, which refused to fall with the autumn. In contrast with the western and eastern states, Missouri, with its hot dry summers, possesses few native evergreens. There are only two evergreen conifers to enhance the landscape. Almost everyone knows them by their colloquial names, the pine and cedar. The word *cedar*, in the Old Testament particularly, is often encountered. Surely this use of the word antedates any use of the word in America. Is the cedar from which the temple of Solomon was wrought the same cedar that dots the Missouri landscape?

In the United States, cedar has long been the name applied to two native genera, *Chamaecyparis*, the white and yellow cedars, with species to our east and west, and *Juniperus*, with several diverse species to our west and east, and with one species, *Juniperus virginiana*, the red or pencil cedar, common and well known throughout Missouri. Neither of these coniferous genera is to be confused with the subtropical spanish cedar *Cedrela*, a broad-leaved member of the Mahogany family. The spanish cedar, and to some extent, the red cedar, is the "cedar" of carpentry. The true cedar, so often encountered in the Bible, is none of these. It is in fact much closer related to the pine than to any of our American "cedars." The true cedar was even first classified as a pine by Linnaeus, the founder of modern systematic nomenclature, who called it *Pinus cedrus*. More recently the genus *Cedrus* has been erected for

the true cedars, which are not even native to the New World.

The true cedar shares two features with the pines; the leaves on mature branches are borne in fascicles, and the cones are large and dry, like those of the pine, as contrasted to the pea-sized cones or "berries" of the white and red cedars respectively. True cedars are different from pines in that the fascicles contain ten to forty needles and do not have a sheath; in the pine there are usually only one to eight needles, and these are bound together at the bottom by a girdling sheath. The leaf arrangement is somewhat reminiscent of the larch *(Larix)*, but the leaves of the larch are deciduous, and the scales of the cone are persistent. In the true cedar, the scales of the cone fall shortly after a heavy rain leaving a denuded spool-like central axis. Another characteristic feature of the true cedar, which becomes evident only in the older trees, is the flattened top. This is illustrated nicely in the photograph of the Mt. Atlas Cedar in cultivation at the Kew Gardens.

Among the true cedars, three species are generally recognized, although the differences between them are often very obscure. These are the Mt. Atlas or Atlantic Cedar *(Cedrus altantica)*, from northern Africa; the Himalayan or Deodar Cedar *(Cedrus deodara)* and the Cedar of Lebanon *(Cedrus libani)*, both from the mountains of Asia Minor. Today after more than six thousand years of lumbering without foresight, the cedars are very localized in their natural distribution. Evidence from fossils suggests that they were once much more widespread, occurring in Europe, even in Great Britain.

The Mount Atlas Cedar *(Cedrus atlantica)* has needles which are mostly

Cedrus atlantica, Kew Garden

Cedrus deodara, Linnean House

less than an inch long; its branchlets are minutely hairy, and its cones are two to three inches long, with flattened or concave tip. In other respects it resembles the Cedar of Lebanon, and both possess rather stiff branches in contrast to the "weeping" Deodar Cedar. The Mt. Atlas Cedar, a native of northern Algeria and Morocco, where snow often lies for several months, should prove fairly successful in the St. Louis area. It does not seem to be widely planted here. Among several varieties, the variety *glauca* is especially attractive because of waxy blue foliage.

The Deodar Cedar *(Cedrus deodara)* has needles one to two inches long. Its branchlets are also minutely hairy, and its cones, rounded at their tips, are the largest among the cedars, attaining a length of three to five inches or more. At a distance, the Deodar Cedar can be differentiated from other cedars by its gracefully pendent leaders and branchlets. Its cones are a bit more colorful than those of the other cedars, because of a rusty cast added to the rather prosaic brown of most cones. The Deodar occurs naturally in the western Himalayas, from Afghanistan to Sarhwal, where it may attain a height of two hundred feet or more and a girth of fifteen to twenty feet. Unfortunately the Missouri climate is rather detrimental to this, the most attractive of the cedars, and it is rarely successful in this area. It is presented nicely in the Camelia House at the Garden, where the humidity is more favorable. As all species of cedar, this is, or has been, an important timber tree, and at one time or another it has been used as a pharmaceutical. Pliny mentions the distillation of "Cedria," an archaic remedy for toothache, closely akin to creosote, a more recent, but nevertheless archaic, dental panacea.

Cedrus libani, Gray Summit

A perusal of the books of Kings I and II and Chronicles will yield an abundance of references to the Cedar of Lebanon *(Cedrus libani)*, for millenia a conifer of both economic and aesthetic importance. This stout tree has leaves which are usually a little more than an inch long. The branchlets are nearly or completely devoid of hair, and the cones, which are apically flattened or concave, range from three to four inches long. At home in the mountains of Asia Minor, but widespread through cultivation, this is the most common of the true cedars cultivated in the St. Louis area. At the Garden, there is a small specimen

thriving in front of the experimental greenhouse. At Gray Summit is a specimen about thirty feet high, which is yet too young to show the characteristic flat-topped appearance of the older cedars. You will note that the tree is twinned, which seems to be the rule rather than the exception in the cedars in their natural habitats.

In contrast to most of our native North American conifers, the cedars typically shed their pollen in the fall. Like the pine at time of pollination, the cedars release torrents of golden pollen when disturbed by the wind or the botanist or whatever. The tree at Gray Summit was so heavily laden with pollen last October that it appeared to be diseased. As in many conifers, the male and female cones are borne on different branches or even on different plants. No female flowers were found on the tree at the arboretum so until such are found, we may assume that our tree is a male. Conifers present many sexual anomalies however; some are strictly males and females; others may produce male and female cones on the same tree in varying proportions in different years; in still others aberrations are not at all uncommon in which a single cone may be partly female and partly male.

Cedrus deodara, female

Cedrus atlantica, male and female

Cedrus libani, male

As told in the second book of Chronicles, the story of the construction of Solomon's temple, seven years in the making, gave to the Cedar of Lebanon a dominant role. Even Solomon's sedan was cedar. Thousands of conscriptees and slaves were sent into the mountains to strip them of their cedars, destined to be used in one or another of Solomon's projects. Since the cedar was the preferred lumber of the Israelites and their neighbors, the cedar population has long since been decimated. This doubtless contributed, in a limited extent, to the aridity problem which challenges the Israelis today.

Then as now the cedar is a symbol of strength to many people. Strength is not the only attribute of the wood. As in many conifers, resinous by-products of the plant's metabolism are concentrated in the wood. These resins impart a lasting quality to the wood so that it is particularly desirable for structures which must endure prolonged contact with the soil. Egyptian mummies were often encased in caskets of cedar, probably the Mt. Atlas Cedar, and many ancient artifacts, carved of cedar, have survived ages of weathering. Probably most important to us is the beauty of the legend tree, the Cedar of Lebanon, but there is little need for me to extol it more. Terse but adequate praise can be found in Psalm 92: verse 12: "The righteous shall flourish like the palm tree; he shall grow like a cedar in Lebanon."

THE ANACARDS

C. H. DODSON

THE Cashew Family, Anacardiaceae, is a family which carries a vary bad reputation here in the temperate climes. We are most familiar with its representatives here as "Poison Oak and Ivy" and "Poison Sumac." Most of us tend to carefully avoid them when we recognize them by their glossy, greasy looking foliage and gray-white, sticky berries—the red berried sorts being considered harmless. It is wise to be careful, for the results of contact with the resins produced by the plants can be most uncomfortable and can even cause severe dermatitis in susceptible persons. Poison Oak and Poison Ivy are normally considered as being botanically the same species, *Rhus toxicodendron*, common throughout the United States either as an erect, numerously branched shrub or as a scandent, or climbing vine which covers up the trunks of trees and rock faces. Both of these forms cause an annoying rash on the average person's skin, usually in the area of contact. Some persons are not affected by the plant while some few people become seriously ill as a result of their encounter. Poison Sumac, *Rhus vernix*, is a native of eastern United States and is considered as more serious than poison oak. It is one of the earliest plants to change the color of its leaves to bright red in the early fall, and unwary persons occasionally collect it for indoor decoration—with unhappy results. Several harmless spe-

cies appear nearly identical with it in habit of growth, leaves, and flowers, but the only easy way to separate the vicious species from the harmless is by the berries. The harmless ones have bright red berries and the toxic ones have dirty-white berries.

Several of the tropical members of the family are also surprisingly venomous to the unwary. *Metopium* and *Comocladia*, from the Carribean region and Central America, are intensely poisonous. *Rhus striata*, closely related to our Poison Sumac, is quite dangerous. The natives refuse to cut it when clearing the forest for agricultural purposes, saying that the tree "burns."

To illustrate what can happen to a fledgling tropical botanist when he is not careful, I would like to relate a short but sad episode. A few years back I was making population studies of some of the variable orchids in Ecuador. One of the projects was to study and collect a particularly beautiful and seldom seen species of *Schomburgkia* in the Province of Esmeraldas. We were in one of the dry desert-like valleys on the western slopes of the Andes which seem so strange, for only a few miles away can be seen the soggy tropical rain forests which receive heavy precipitation throughout most of the year. These dry valleys result from the moisture-laden clouds being strained of their moisture by the sheltering mountains and little rain is left when the clouds reach the valleys.

It was an extremely hot day. As we wandered along we noted that the natives had all but cleared the region of trees and shrubs which were large enough to provide fire wood. Rather than attempt to climb the few remaining large trees to collect the flowering orchids we looked about in search of a tree or bush from which we might cut a pole to use in dislodging the plants. One can remove them with a good pole with ease and we were not in a mood to exert ourselves any more than absolutely necessary. Around a bend in the trail we came upon a small tree of just the characteristics necessary and after a few machete whacks we had a remarkably long and light pole suited to our needs. It was so excellent in fact that I personally carried it for the rest of the day, using it regularly. I noticed that it seemed to be exuding a black greasy substance but I dismissed that fact in the excitement of the collecting.

Late in the afternoon a young man came sauntering down the trail, smiling and saluting us. He was curious as to what we were doing with the orchid plants and stopped to chat. His eyes came to rest on the pole in my hands and suddenly his facial expression changed to one of horror and he immediately turned and bid us good day. "Strange people, these Ecuadorian counterparts of our hill billies," I thought as I wiped the sweat from my brow with my hand.

There was no hotel in this region and no water for bathing and since we had worked late we bedded down on the floor of a friendly soul's front porch and spent the night. The following morning I felt strange. A combination of symptoms of extreme sunburn, horrible itching and general swelling throughout my body made

me feel that this little expedition should come to an end. The following two weeks in the hospital—swollen out of all proportion to a human being and thoroughly miserable—gave an opportunity to reflect on the reasons for the strange behavior of the young man on the trail. It also dawned on me that any small tree left in an area where all others had been cut for fire-wood should be suspect.

After recovery I went back to make a careful but more critical examination of my orchid pole tree and it turned out to be *Rhus striata*. Discussion with the local inhabitants of the region revealed several interesting things, mostly based on folk lore but with an obvious basis in reality. I was informed that sleeping under the tree was certain death. That just walking past the tree could lead to dire results if one were not careful to tip his hat and give a pleasant greeting.

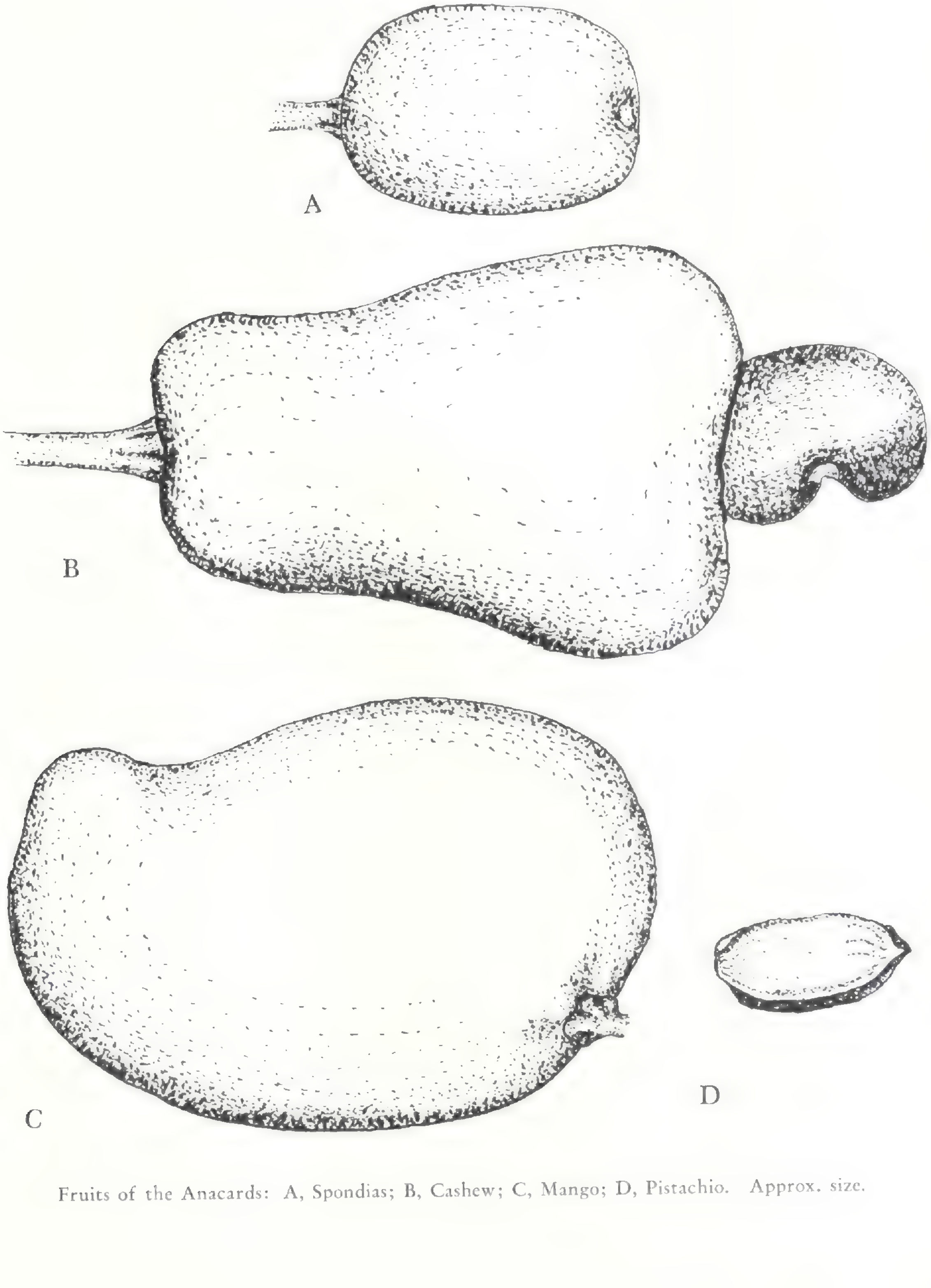
Not all of the members of this family are poisonous; in fact it is only a small minority that are so endowed. For instance, in the genus *Rhus* approximately 150 species are known, of which only 5 or 6 are poisonous. *Rhus glabra*, the "Smooth Sumac," was used during the pioneer days to make a kind of lemonade by dipping the fresh fruit panicles into warm water and then cooling.

Few of us realize that several of the most appetizing fruits and nuts of tropical regions belong in this family. Scarcely a more delicious fruit is to be found than a really good variety of Mango, such as Hayden, with which perhaps only a fine peach can compare. It is a sad fact, however, that few of the really good new varieties of Mango developed in Hawaii and the Philippines, are common in cultivation in tropical American countries. This does not bother the children, however, for during Mango season the streets are littered with the large fibrous seeds. This very situation of numerous seeds being scattered, germinating and growing quickly into producing trees, has contributed to the lack of good varieties. Also, the unselected seedlings pollinate and thereby soon degenerate the better varieties. Most persons in Latin America simply harvest what is available and are not too concerned because the fruit is small, fibrous and has a flavor of turpentine.

In places like Hawaii and the Philippines, Mangos are carefully selected to improve the strains and most of the fibers and unpleasant flavor of the rinds have been removed. A visit to the Agricultural Research Station of the University of Hawaii in September can be a pleasant sojourn with seemingly countless varieties to taste and compare. Also one can occasionally leave with a distressing rash when he discovers that he is allergic to Mangos.

Few people here know that the Cashew Nut, *Anacardium occidentale*, is distantly related to Poison Oak and that in Tropical America most people eat the stem and throw the fruit away. Actually, the fruit in this plant is the nut as we know it, including an outer shell which is stripped off when the nut is roasted. The part that the Latin Americans eat is technically the swollen receptacle, or stem, of the fruit. It is about the size of a large plum and is soft and juicy. The nut

it attached to the apex of this swollen receptacle and the name of the family —Anacardiaceae—is taken from the heart shaped outer cover of this nut. The "Maranons," as this fruit is called there, is very popular. The fruit-like receptacles are delicious fresh and are made into sherbets, soft drinks and



Fruits of the Anacards: A, Spondias; B, Cashew; C, Mango; D, Pistachio. Approx. size.

even fermented to produce a kind of tropical "white lightning." Unfortunately, the fruit is so delicate that it cannot be shipped and therefore we never see it here on the market. As if to show its relationship to the Poison Oak and Sumac, this beautiful small tree also produces a strong poison but in this case the poison is in the shell which covers the nut. If this shell is carefully removed from the fruit, no danger is involved in eating it. After the nut has been roasted it, too, is not only harmless, but as we well know, delicious.

One other species of *Anacardium* is common in southern Central America and northern South America. This is *Anacardium excelsum,* a giant forest tree from which the natives make their dugout canoes. It also produces an edible fruit but is inferior to *Anacardium occidentale.*

The well known, but expensive nut, the Pistachio, *Pistacia vera,* belongs here. This tree is a native of Asia but we have a species of the genus indigenous to southern Texas. Nearly everyone enjoys popping open the husks of Pistachios and picking out the richly flavored meats once they have been roasted and salted. Unfortunately, the demand outstrips the supply and thus they have remained a luxury item.

Another popular fruit from this family in tropical America is the "Mombin" or "Ciruela," *Spondias mombin,* often called the "Spanish Plum." The thick-branched, low trees are common throughout tropical regions, particularly in dry areas, and are both semi-cultivated and wild. The fruits are about the same size, shape and color as our red plums and have a remarkably similar flavor, being slightly acid. During certain periods of the year they are very common in the market places and are quite inexpensive. An estimate of the enormous number of these trees can be based on the fact that children eat the nuts with salt, voraciously, while they are still completely green. Considering the quantities which reach the market after that onslaught, one comes to realize that it is a common tree. Unfortunately, some persons, the author for instance, are allergic to these Anacards as well as to Poison Oak.

A number of plants from the family make excellent horticultural subjects grown for their foliage, particularly in tropical and semi-tropical regions. Several varieties of Rhus, as the Staghorn Sumac, *Rhus typhina,* are grown in our gardens. Few trees are more beautiful than the large Mangos grown in tropical areas. *Campnosperma* and *Semicarpus* are also well know in tropical and semi-tropical regions for their beauty. *Schinus terebinthifolius* and *Schinus molle* are common in southern California and Florida. The "Smoke Tree," *Cotinus cogygria,* is an extremely colorful small tree or shrub in our gardens because of its densely plumose, purplish panicles of flowers, followed by plumose sterile pedicels accompanying the filiform ones. The "pink smoke tree" is a handsome new form with bronze colored leaves.

EXTRAORDINARY USES OF LEGUME SEEDS

Ever since the Cro-Magnon man rolled a pea seed in his hand and fingered a hollow stem, only to realize its potential as a pea-shooter, the legumes have had a variety of uses apart from culinary or medicinal applications. Such variety represents a fascinating gamut. Witness, for example, the mundane use of beans in the game of bean-bag. Recently in examining a stuffed alligator-skin about 2 feet long, I noted that the scarlet "eyes" with a black "pupil" were the brilliant red seeds of *Erythrina*; this close relative of the familiar coral bush has a plack spot near the seed scar *(hilum)*. The large plump and rotund seeds of a tropical vine *Mucuna* are called *donkey's eyes*, bearing a striking resemblance to the eye of this animal.

Equally interesting is the use of the ordinary dry bean seeds (these being large, cheap, and easily procurable) in the process of disarticulating cleaned-out skulls. After pouring the seeds through the large cavity *(foramen magnum)* at the base of the skull until the inside becomes filled, and subsequently immersing the skull, the bones separate cleanly along their natural sutures. Substances in the seed coat, called *hydrophylic* colloids, attract water like a magnet attracts metal; as a result the seed coat swells appreciably. The total force exerted by the over-all expansion of the seeds is tremendous and the bones readily separate. From skulls to rosaries may seem a big step, but we note that the seeds of the *rosary pea (Abrus precatorius)*, as is suggested by the Latin specific name, are widely used in the manufacture of chaplets or beads in tropical countries. In times past the dried seeds of the same rosary pea were frequently employed in the weighing of diamonds; they were erroneously thought to be constant in weight, i.e. the equivalent of a grain or 1/1000 part of a pound avoirdupois. One interpretation of the word *avoirdupois* of the Old French means "to have some peas." It would seem to suggest that peas were used in weighings; apparently the word suffered a slight change in orthography and acquired a facetious meaning, being linked with the notion of corpulence. The word *carat* (a weight for gems, about 3.2 grains) is thought to be derived from the Hindu Indian word *retti* meaning seed.

The combustible properties of the fruit of the tropical American arboreal genus, *Dipteryx*, are noteworthy. B. C. White, the author of "The White Indians of Darien" observed (pp. 96–97) that the Indians near the Colombian border of Panama use the fruits of Dipteryx to make torches: "they consist of about 20 nuts of the *almendra* tree, rather like nutmegs in shape and size. They are strung tight against each other on a long black sliver of black palm and when lighted give a light about as bright as a common kerosene lantern. As one nut is consumed, it lights up the next one." In tropical countries the seeds of the leguminous vine, *Entada gigas*, are used as trinkets. One botanist (I. Johnston) described them as about the size and shape of a pocket-watch and

having glossy mahogany-colored coats. Not infrequently they are heart-shaped instead of round and are highly prized as pendants. The fruits which bear them are often longer than a yard-stick.

Peas are used in a routine laboratory experiment to demonstrate that plants like animals "breathe," i.e. carry on respiration. In this process oxygen, passing through the seed-coat, burns as it were, complex foods like sugars; as a result, water and a gas, carbon dioxide are formed, with heat being given off in the process. The peas are divided into two groups, one soaked in water, the other soaked in formaldehyde, and subsequently segregated in 2 vacuum tubes similar to a thermos bottle; these are sealed with corks through which a thermometer has been inserted. Inasmuch as formaldehyde is toxic to living tissue, the dead peas will release no heat of respiration and consequently no change will be noted in the mercury column of one thermometer; the other tube with the water-soaked seeds, will show in a short time an obvious rise in the mercury column, reflecting the loss of heat through the oxidation of the substances in the respiring seeds.

It is a apropos to point out that the so-called *Mexican jumping beans* (really fruits of *Sebastiana palmeri*) are not beans in the sense of belonging to a species of leguminous plant; they are derived from a species of the spurge family (Euphorbiaceae). The jumping effect of the bean is due to the writhings of a lepidopterous larva living inside the fruit.

Despite the importance of any kind of seed, whether from legume, mint or rose, in terms of food, medicine, industrial use, decoration or experiment, its prime significance is its possession of a living embryo. As the hope and perpetuation of the human race can be interpreted in a sense in terms of the maternity wards of our hospitals, so the hopes for a perpetual Spring lie in the womb of the earth with its variety of seeds, each one sustaining a miniature plant eager for its hour of emergence.

J.D.D.

THE PELLITORY PROBLEM II

In the BULLETIN for October we presented the strange case of our native pellitory, *Parietaria pensylvanica*. It has become a common weed in St. Louis, though neither in the literature nor in the herbarium can we find any record of its having been weedy, here or elsewhere. Since the article appeared, Dr. V. Muhlenbachs, an honorary member of our staff, has come forward with even more precise evidence as to its status in St. Louis.

Since 1954 Dr. Muhlenbachs has been engaged, in his spare time, in producing a flora of the railroad tracks and freight yards in the City of St. Louis, a precise record of the weeds and waifs, (and occasional survivor of the original flora) which are to be found growing under these unusual conditions. Dr. Muhlenbachs has collected the pellitory five times and has seen it on other occasions, sometimes growing in great abundance. It has

been collected on both the Wabash and Missouri Pacific rights of way; not only along the tracks but also in the large freight yards. There is even a suggestion, as at the Garden, of the kind of way in which it might have spread from its original site to the railroad properties. Dr. Muhlenbach's first collection on June 13, 1954, was along the M. P. right of way near Dover Street where, as he says, "the tracks enter the narrow space between the levee of the Mississippi and the steep and very high bluff." At such a site the pellitory might have made its transition from its original status as a rock plant to an ubiquitous weed. Elsewhere along the tracks and in the freight yards Dr. Muhlenbach's impression of it is of "a typical weedy species, growing copiously in more or less dense colonies."

A former member of the Horticultural Council, Mr. Robert Waln, of Drexel Hill, Pennsylvania, has written about his experiences with the weediness of *Parietaria pensylvanica*—"When a boy, my father charged me with the task of eradicating *Parietaria pensylvanica* from our Bonny Brook Farm, near Clearfield, Pennsylvania, after learning I had transplanted some from a restricteed area of our Sunny Steppe Farm in the Grampian Hills twenty miles distant."

This additional evidence merely points up the problem posed in the original notice. Has this native rock-plant just recently made the transition to weed-dom in the St. Louis area or has this been going on generally for a long time but outside the notice of scientists?

E.A.

MAUSOLEUM RESTORATION

THE mausoleum of Mr. Henry Shaw, started before his death in 1889 and finished shortly thereafter, has been completely renovated and made secure for at least an equal time to come.

The work was planned and ordered by the Historical Committee of the Women's Association of the Garden in the Fall of 1960. The renovation was under the direction of Mrs. Fothergill Graves, Special Consultant, with the metal work and most of the detail being handled by Mr. Robert T. Theiss of the Theiss Plating Corporation. The leaded glass windows were repaired and reset by Emil Frei, Incorporated. The stone work was cleaned by the

Vittert Building Cleaning Company. The painting was done by the J. R. Meade Company. The roof repairs were made by the Mound City Roofing Company.

The structure as it was originally built was solid and amazingly true. Little or no settling has taken place over the years. The recent cleaning and renovation reveals the beautiful pink Missouri granite, the brightly colored leaded windows and restores the quiet dignity which was Mr. Shaw's wish for this tomb, his final resting place.

E.L.E.

MISSOURI BOTANICAL GARDEN EDUCATIONAL PROGRAMS

SPECIAL SHOWS AND DISPLAYS

Orchid Show, January 22 to February 26th.

FREE NATURE PROGRAMS for children, aged seven and over, are held every Saturday morning from 10:00 to 11:30 A. M.

The Mystery of the Orchid, February 4th
The Green Thumb at Work, February 11th.
Color Sound Movies, February 18th.
Plants in a Capsule, February 25th.

COURSES FOR ADULTS. Beginnning in February:

Area Management, 4 sessions; fee $8.00. Wednesdays, February 1st to 22nd, 8:00 to 9:30 P. M.

Practical instruction on erosion control, weed and brush control and basic management of ponds. Specialized instruction in management of meadows, marshes and forests will be explained, emphasizing recreation and wildlife.

SPECIAL LECTURE ANNOUNCEMENT

FOR

MONDAY, FEBRUARY 6, 1961, AT 8:00 P. M., MUSEUM BUILDING

Dr. Arthur Ringoet, recently from the Congo, will introduce and show a color film to illustrate the work of the Belgian Agricultural Research Institute in the Congo. Dr. Ringoet is now engaged in research at the Garden on the translocation of sugar in rice. This work is supported by a grant from the Rockefeller Foundation.

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Trifon von Schrenk.....Associate Curator of the Museum
Robert E. Woodson, Jr.....Curator of Herbarium

SOME FACTS ABOUT SHAW'S GARDEN

The Missouri Botanical (Shaw's) Garden was established in 1859 by Henry Shaw, a St. Louis businessman, to be controlled by a Board of Trustees for the public benefit. The Garden is a non-profit institution which receives no support from the city or state, depending on the income from the Shaw estate supplemented by contributions from the public.

The old stone walls and cast-iron fences, the Linnean House, the Museum Building, the part of the Administration Building which was Shaw's Town House, relocated in the Garden in 1890, and the Tower Grove House, his country home, all date from Mr. Shaw's time. The Main Gate, display and growing greenhouses and most other facilities date from the period immediately following the turn of the century. The Climatron, opened in 1960, is the first of several new buildings planned for the Garden's redevelopment. It is the world's first geodesic dome, fully climate-controlled greenhouse and contains the Garden's tropical collections.

The Garden — 70 acres — is open every day of the year (except Christmas and New Year) from 9 A.M. until sundown, and the greenhouses close at 5 P.M. Tower Grove House is open daily from 1 P. M. to 4 P. M. (December to March on weekends only). The Display House presents four seasonal displays:— November, Chrysanthemums; December, Poinsettias; February, Orchids; Spring, Lilies and other flowers. During the year are other shows, competitions and festivals sponsored by various Garden Clubs and Flower Societies.

Courses in Botany and Horticulture for adults are conducted by the Garden staff. Children's nature studies are provided each Saturday of the year and a special nature program is held during the summer. Information on these activities is published in the BULLETIN or may be had by mail or phone. The Garden maintains a research program through the Henry Shaw School of Botany, Washington University.

In 1926 an Arboretum — 1600 acres — was established at Gray Summit, Missouri. Foot trails and roads pass through the Arboretum and are open to visitors in April and May.

The Garden Administration Building is located at 2315 Tower Grove Ave., and the Garden main entrance is at Tower Grove and Flora Place. The entrance at Tower Grove and Cleveland Avenue is also open to the public. The Garden is served by both the Sarah (No. 42) and the Park-Southampton (No. 80) city bus lines.

Persons interested in helping to support the Garden and taking part in Garden activities are urged to do so through the "Friends of the Garden". Information may be obtained from the Main Gate or by mail or phone.

MISSOURI BOTANICAL GARDEN

Bulletin

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COVER: Inside Climatron showing bog area soon after planting.
PHOTO BY HEDRICH-BLESSING

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Report of the Director for 1960

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MISSOURI BOTANICAL GARDEN REPORT OF THE DIRECTOR FOR 1960

FRITS W. WENT, Director

If success of an institution is measured by public interest, then the Missouri Botanical Garden has done well in 1960. During the 10-year period 1949-1958, an average of 211,710 persons visited the Garden per year. In 1959 the number was 279,800, or 32% above the 10-year average, and 20% above the previous 20-year average. In 1960 the attendance as measured by turnstile count at the main gate, was 423,302 visitors, which is just 100% over the 10-year average, and 80% over the 20-year average. This attendance has been equaled only once (in 1929) and has been exceeded in 1928 (468,100 persons). If we add an estimated 18% to the main gate count because of persons entering through the Cleveland and Alfred Avenue gates, our attendance last year was half a million. This compares favorably with estimated attendance at the New York Botanical Garden and Kew Gardens near London, of about one million visitors per year, since those gardens are located in areas where the population is about four times that of the St. Louis area.

In our 1959 report we resumed a former practice of publishing the monthly attendance figures, and are including now therewith the figures (in thousands) for 1960 with the 10-year average and 1959 attendance for comparison.

	1960	*1959*	*Average 1949-1958*
January	14.5	5.3	6.6
February	24.2	12.1	12.2
March	11.6	25.6	13.6
April	44.7	25.8	22.1
May	44.6	25.6	23.7
June	29.1	25.3	19.4
July	46.7	27.7	21.4
August	41.6	25.5	22.9
September	30.6	37.3	22.4
October	60.4	40.6	22.7
November	53.1	22.5	20.7
December	22.2	6.0	9.0
Year	423.3	279.8	211.7

From the 1960 figures it will be seen that, with the exception of March which was exceptionally cold and during which the ground was covered with snow practically continuously, the monthly attendance was higher than in similar months during the last ten years. It is also interesting to note that the peak month of April was due to the exceptionally fine bulb displays in the Garden and the excellent Spring Show, whereas the October figures are due to increased interest in the Garden resulting from the opening of the Climatron. The December attendance figure also far exceeds those of previous years, showing to what extent the

Climatron is important in our overall operation.

At present, attendance at the Missouri Botanical Garden on its peak Sundays is limited by automobile parking facilities on Tower Grove Avenue, Flora Boulevard and side streets. Therefore we *must* provide off-street parking if we want to serve the St. Louis public to the extent we believe local interest in gardens and plants is concerned. If no parking limitations existed, we believe that within a few years, attendance at Shaw's Garden would reach a million visitors per year, or about four times that of comparable Botanical Gardens. Even the present achievement must be considered a record for an institution which receives no tax support (except for its scientific activities), and charges no general admission fee.

The reasons for our success are simple. The Garden is located inside the city boundaries of a great metropolitan center. The private benevolence of Henry Shaw, and recently of many prominent citizens, has enabled the Garden to provide unparalleled surroundings for public enjoyment, in addition to the financial support from thousands of St. Louisans as "Friends of the Garden." The devoted efforts of the Garden staff to improve the Missouri Botanical Garden, a certain amount of imagination offering completely new and exciting experiences for our visitors, and educationally interesting information, are providing new pleasures never before offered anywhere. We believe that we can continue this program and improve on it, setting an example for institutions all over the world, proving that Botany and Horticulture are of such universal appeal and significance that their pursuit can sustain a garden of unusual attainments.

The major achievement of 1960 was the completion of the Climatron, which was officially dedicated on October 1, and opened to the public for the first time on October 2. The dedication ceremony was held in front of the East entrance of the Climatron at dusk, and Dr. Detlev Bronk, President of the Rockefeller Institute of New York, gave the dedicatory speech. A very large number of Friends of the Garden, all Trustees, a number of prominent St. Louisans and distinguished out-of-town botanists such as the Directors of the New York Botanical Garden, Longwood Gardens, the Morris Arboretum and the Arnold Arboretum, attended and saw the Climatron opened by the dramatic turning on of the lights. The Women's Association offered refreshments inside the Climatron for all guests at the dedication ceremony. An estimated 1,500 persons filed past the refreshment tables at the lower level of the Climatron.

Right from the beginning, the attendance of paying visitors at the Climatron has been a success. The average weekly income from these visitors has fluctuated considerably but, if anything, shows a tendency to increase. Sunday attendance has always been best, with receipts ranging from $500 to $1,000. We had our peak attendance on Sunday, October 2, with Thanksgiving Day as a close second. During the weeks before

Christmas, attendance was low; however, this is a normal seasonal drop occasioned only partly by bad weather conditions. Weekday receipts average $100, while the average on Saturday is $200. Many school children and other students have taken advantage of free admission extended to those groups.

Since November 3 the Climatron has been open to visitors on certain days between 5:00 and 9:00 P. M. Originally, it was open Thursday through Sunday evenings; however, it developed that the Thursday night attendance was too low to justify the expense involved, with the result that the Climatron is now open Friday through Sunday evenings. Sunday evenings always bring the greatest number of late visitors, and again on Thanksgiving, there were more evening visitors than on any other night.

During the first week that the Climatron was open, a series of lectures was given in the evening for Friends of the Garden, as follows:

October 2, 1960, Dr. Erwin Bünning, Director, Botanical Institute and Garden of the University of Tübingen, "Biological Clocks in Plants"; and Dr. Edgar Anderson, Curator of Useful Plants, Missouri Botanical Garden, "Experimental Research at Shaw's Garden."

October 3, 1960, Dr. Russell Seibert, Director, Longwood Gardens, Kennett Square, Pennsylvania, "The Significance of the Privately Operated Botanical Garden."

October 6, 1960, Dr. Frits W. Went, Director, Missouri Botanical Garden, "Plants and Gardens in the Western Hemisphere."

These lectures were fairly well attended. It was interesting to note that, with the proper public address system, the speaker could be heard, although the acoustics of the Climatron, from the lecturer's point of view, are not ideal. On the other hand, the acoustics are excellent for the different jungle noises and the sound of the waterfall, all of which reverberate through the entire building to the extent that it is impossible to determine their exact source, with the resultant very natural effect.

In June Ladislaus Cutak went to southern Florida to select and dig palms and other materials to be displayed in the Climatron. Mr. C. A. MacFall, Jr., of the Lee Freight System, donated a truck for transporting this material to St. Louis. The plants were given to the Missouri Botanical Garden by the Fairchild Tropical Garden, Mrs. Alvin R. Jennings and the U. S. Plant Introduction Garden. This material was temporarily kept in our other greenhouses, and in August was planted in the Climatron. Further plantings were made in September and succeding months so that, by the time the Climatron was officially opened, the visitors were greeted with a fine display of vegetation.

Much of the plant material is growing very rapidly, and within a few years we can expect to have most of the space in the Climatron filled with the more rapidly growing tropical trees and shrubs which then can be gradually replaced with the typical primary forest trees of the jungle.

On June 15 C. Ranlet Lincoln assumed the position of Assistant to the

Director, and his efforts have been most effective in handling many phases of construction and operation of the Garden.

During the summer the Director and Mrs. Went traveled through Europe, visiting Botanical Gardens and parks. One of the main objectives was to find the best features of these gardens and parks, with a view of incorporating them in the Missouri Botanical Garden.

The places visited ranged from the purest Botanical collections with little attempt to make them attractive to the public, to an amusement park with attractive flower gardens (Tivoli in Copenhagen). As far as attendance is concerned, Tivoli had the greatest popularity, with free concerts, shows, circus performances, an amusement park for both adults and children, and many restaurants (a total of 9,500 seats). During the 4½ month season a million persons pass through the Tivoli gates *per month*, which compares with a similar attendance *per year* for Kew Gardens in London, and the New York and Brooklyn Botanical Gardens, and of Planten un Blomen in Hamburg and the Palmengarten in Frankfurt. The latter two have attractive restaurants, very colorful flower displays, music and other attractions, which explains their popularity in cities considerably smaller than London or New York. But in none of these Gardens or Parks were the *plants* displayed for their own sake, nor were their interesting aspects, morphologically, taxonomically, gastronomically or economically, sufficiently stressed. Both Tivoli and Planten un Blomen are self-supporting and do not need any tax-money. The number of seats in their restaurants are 9,500 and 9,000 respectively.

Since we do not want to become an amusement park, and since the Garden has to become self-supporting, we will have to stress 1) eating facilities, 2) special attractions like the Climatron, 3) attractive floral displays throughout the year, and 4) botanical information of the highest order of interest and practical significance.

Several experiences of special interest were 1) the realization that the baroque style, as exemplified by many churches in Bavaria, Austria and Czechoslovakia, have a spirit akin to the richness of flowers and the grace of floral displays, and that it would be highly appropriate to build any new Floral Display house in this style. Originated by Michelangelo with his creative exuberance, it became generally accepted because of its bigness of scale, boldness of details and the vigor of its rhythmic flow. In general, Floral Display houses are conventional greenhouses (like our present one) of which the basic architectural outlines have to be softened by camouflaging them with trees and palms, or they are just barns, erected for cheapness, of which one hopes that their structure will be de-emphasized by color and grace of the flowers displayed.

2) One of the finest gardens visited, but the least satisfying, was Saville Gardens in Windsor Great Park in England. These gardens were laid out somewhere in the middle of the stately semi-wilderness of the old

hunting grounds of the English kings. Since there is no house or other human structure in or near the gardens, they seem to lack a purpose, and seem lost, in spite of their design. A lawn which does not provide a view from a window, or walks which neither start nor end are an artifice in the domain of nature.

3) Everywhere, in England, Holland, Denmark, Germany and Czechoslovakia, old private estate gardens are made into public gardens and in general a nominal admission fee is charged as a contribution to operating expenses. But we had the impression that admissions could pay only for a small fraction of the actual running costs. Besides, most of these estates are too far away from metropolitan centers to attract a sufficient number of visitors.

4) In most of the Botanical Gardens with particularly rich botanical collections, one or more professional botanists were employed to build up the living collections (Kew, Münich, Göteborg). Not only the greenhouse collections, but also the outdoor taxonomic plantings, the rock gardens and arboreta were rich in forms wherever special efforts were made to develop and maintain such collections through seed and plant exchange and through special expeditions.

5) Wisley Gardens of the Royal Horticultural Society occupies a special place because of its large-scale testing of plant materials and planting methods. They can also be described as demonstration gardens such as we want to establish here at the Missouri Botanical Garden.

This year the Director again has spent much time in lecturing: University of Pittsburgh, University of Florida, American Meteorological Society, Kansas City Meeting, Southern Illinois University, Cold Spring Harbor Symposium, Purdue University, Sorbonne (Gif Phytotron), University of Utrecht, Vegetable Research Station in Olomouc, Czechoslovakia, Agricultural Research Institute of Canada, Pioneer Hybrid Corn Company, Des Moines. In addition, he has given talks for local groups of gardeners and professional people. He also attended many meetings concerned with botanical problems, such as a tree growth conference in Tucson, a committee on Tropical Botany, and meetings of the Governing Board of the American Institute of Biological Sciences and of the National Committee of the International Union of Biological Sciences.

In September a Visiting Committee of the National Institute of Health was at the Garden for a day in connection with the Garden's application for a facilities grant for the new Research Building, for which we already had a $250,000 grant from the National Science Foundation. This Committee obviously made a favorable recommendation, since we have received word that the National Institute of Health recommends a grant of $188,281 toward the new Research Building.

Preliminiary architectural plans for this building were made by the architects Murphy and Mackey, including laboratories for experimental work, a library and an herbarium which would

virtually double our present space.

During the past year the Garden has received a great deal of publicity, especially in connection with the opening of the Climatron. This publicity was local, national and international, and consisted of newspaper spreads and radio and TV programs, in which many staff members participated, particularly George Pring.

One of the major activities connected with the Garden was the work of the "Friends of the Garden." Under the able leadership of newly appointed officers, Mr. John Averill, President; Mrs. William Bascom, Vice President; Mr. Sears Lehmann, Treasurer; and Mr. Harry Wuertenbacher and Mrs. Curtis Ford, Co-Chairmen of the Membership Committee, a major membership campaign was started which, in spite of an increase in membership fee from $5 to $10, materially increased the number of members in this organization and almost doubled the income of the previous year.

The Historical Committee, organized in 1959, continued its work in 1960 and in addition to further improving the restoration of the Tower Grove House, also restored Henry Shaw's Mausoleum, which is now again in prime condition. This work was financed by income from admission fees from the Tower Grove House, and by a contribution from the Women's Association.

The Women's Association expanded on its already impressive record of devoted, imaginative and most effective service to the Garden. Under Mrs. W. Warren Kirkbride's splendid chairmanship, the ladies were not content to rest on their laurels, or even to

"Through the Garden Gate" exhibition 1960 PHOTO P.A.K.

repeat their past successes, but continually devised new and attractive projects. Outstanding among these during the past year were: The "Pass the Hat" campaign, restricted to the Association's membership, in which gaily-decorated miniature hats accompanied an appeal for funds, phrased in verse by Mrs. Henry B. Pflager who, with Mrs. Charles A. Brandon, directed the campaign; and the Garden Gate exhibition and sale of garden material in May. This highly successful project was sponsored by the Famous Barr Company, and held at the parking lot of the Famous Clayton store. With an enormous quantity of creative effort by the Association, led by Mrs. J. Bruce Butler, the Garden Gate not only earned over $5,000 which was donated to the Garden, but also established itself as a new feature of spring in St. Louis. It will be held again in 1961, and the Association is confidently expecting to double the proceeds.

In addition to his administrative duties, Hugh Cutler continued his research on useful plants. This was supported by a National Science Foundation grant. During the summer he was assisted in this work by Michael Wynne, a botany student at Washington University. In May, Cutler took part in the conference of Directors of Systematic Collections at Lawrence, Kansas. During August he participated in the Pecos Conference at Flagstaff, Arizona, and studied plant collections in institutions in New Mexico and Arizona.

From February through August Edgar Anderson was in residence at the Garden, and spent most of his time in research and writing. From September on, he taught and consulted at Connecticut Wesleyan College, Middletown, Connecticut.

THE HERBARIUM

ROBERT E. WOODSON, CURATOR

ALTHOUGH no one event may be singled out as particularly significant, the year 1960 has been a highly satisfactory one in the herbarium. Gains of the past few years have been consolidated and small, but consistent advances made on all fronts.

A total of 18,425 specimens were mounted and incorporated in our collection, bringing the estimated content of the herbarium to 1,759,281 sheets. (The number added this year is almost half that of the preceding year, which reflects pressing need for the conservation of our inadequate space.) 6,612 sheets were forwarded as loans requested by other institutions, of which we take a bit of pride in noting that almost one-quarter were sent outside the U.S.A. In the same period the Missouri Botanical Garden received on loan from other museums 5,513 specimens for research of our staff and students. 4,358 specimens were received on exchange from other museums and we reciprocated with 1,725 sheets.

As in many previous years, the principal research project of the herbarium has centered about the "Flora of

Panama," in which Woodson has received indispensable collaboration from James A. Duke, C. H. Dodson and R. L. Dressler of our own staff and specialists of other institutions. During 1960 two new fascicles were published. An outstanding feature of the "Flora" are the numerous beautiful and very critical line and stipple drawings prepared by Bernadette Velick. The "Flora of Panama" is supported by grants from the National Science Foundation.

A second group project of the herbarium staff was the identification of very many plants of Peru collected by Mr. Felix Woytkowski because of their therapeutic or ceremonial use by aboriginal tribes, particularly in the Amazonian headwaters. This research, undertaken under the auspices of Ciba Pharmaceutical Products, Inc., of Summit, New Jersey, is one of the more ambitious projects dealing with drug plants with which our staff has been concerned for most of the past decade, in cooperation with numerous concerns of the pharmaceutical industry. Such activity carries on the role in the interest of public health which the Missouri Botanical Garden has played since the pioneer research on viruses initiated by the late Dr. B. M. Duggar, for many years our plant physiologist, and the fundamental studies of medically important fungi by our present mycologist, Carroll W. Dodge.

In addition to the "Flora of Panama," Woodson has continued his study of population problems in the butterflyweed, *Asclepias tuberosa*, which is supported by grants from the National Science Foundation, as are the studies of Dodge on Antarctic lichens, of Bunting on *Philodendron* and those of Dressler on orchids. A particular pleasure to our staff has been the association with one of our alumni, Dr. Richard W. Holm, now of Stanford University, who is spending a sabbatical year with us.

As sparetime projects Duke is finishing a revision of the genus of *Drymaria*, a weedy tropical genus of some 75 species, and is beginning a revision of the genus *Triplaris*, a group of tropical ornamental trees cultivated throughout Central and South America and the West Indies.

Robert Dressler together with Cal Dodson completed for publication in 1960 the "Classification and Phylogeny in the Orchidaceae," though this really represents work done for the most part in 1959. This review and evaluation of orchid classification with some ideas on relationship and phylogeny, has provided a background for much of our future work and has stimulated interesting correspondence with a number of colleagues. A number of short notes have been published, some of which are technical, and some in a more popular style.

A proposal to the National Science Foundation for support of this work has been granted. A small grant ($400.00) was obtained from Washington University Graduate School Special Research Fund, which is to be used in the preparation of illustrations of orchids for these research studies.

Dressler attended both the Second Mid-America Orchid Conference in Chicago, and the American Institute of Biological Sciences Meetings in

Stillwater, Oklahoma. Papers were presented at both meetings.

George Bunting has had his activities divided between the herbarium and the living collections. He assisted in identification of many dried collections from Peru and Panama, as well as specimens sent in by the public for determination. An attempt has been made to name all living plants in the Climatron and other greenhouses. Laminated plastic labels recording pertinent data about the species have been prepared and applied to the specimens already determined.

Throughout the flowering season of daffodils *(Narcissus)*, the named varieties and some unnamed seedlings (known as "Powell hybrids") were observed, their locations mapped, and notes made concerning their excellence for use in gardens in the St. Louis area. This project was aided by Josephine Davies, Mr. and Mrs. George Pettus, Kenneth Peck, Mrs. Frits Went and Edgar Anderson.

Cal Dodson was given a temporary position beginning in September as a Research Associate for the "Flora of Panama" project. He has worked on the families *Anacardinaceae* and *Sapindaceae* and is nearing completion of this phase of the project. In addition, his spare time has been devoted to the completion of a revision of the subtribes *Stanhopinae* and *Catasetinae* of the family *Orchidaceae*.

The pride of our herbarium, as for the Henry Shaw School of Botany of Washington University as a whole, always has been our students. At the June commencement the degree of Ph.D. was conferred on Loren I. Nevling. Nevling is now assistant curator of the herbaria of Harvard University where he has for associates two fellow alumni from the Missouri Botanical Garden, Dr. Clarence E. Kobuski, his immediate superior, and Dr. Lily M. Perry. Post-graduate students presently in residence and their respective research topics include William C. Burger (*Sorocea* and related genera of Moraceae), Phung Trung Ngan (The Asian genera of Cynanchoideae), Gordon Hunter (the Central American species of *Saurauja*), Howard Pfeifer (the North American and Antillean species of *Aristolochia*), Samuel W. Rosso (the tribe Apostasieae of Orchidaceae), and Fuad M. Safwat (the evolutionary morphology of the asclepiad anther). Burger, who came to us three years ago with the degrees of A.B. from Columbia University and A.M. from Cornnell University, expects to receive the Ph.D. at the June 1961 commencement of Washington University.

During much of 1960 the curator, Robert E. Woodson has been conspicuous by his chronic absence from the herbarium because of imposed substituting at the University for Dean Andrews, who is spending a sabbatical year in India. Yet the routine has moved smoothly, thanks to the understanding diligence and close coordination of the rest of the herbarium staff: James A. Duke, assistant curator; Barbara Mueller, secretary; George S. Bunting, taxonomist; Gordon Hunter, graduate assistant; Cindy Rosso, mounter; and Jack Wasinger.

THE LIBRARY

GEORGE B. VAN SCHAACK, Librarian

Acquisitions, cataloguing and binding occupied as usual much time of the library staff. In addition to the several hundred serials normally added to the collections, 213 new titles were catalogued. The number of books bound was 408. The project, reported last year, of reproducing the catalogue and shelf list on standard size cards was completed late in the year. The long delay in finishing this work, the result of the contractor's unsuspected lack of technique, was a major burden for eighteen months. Since a library catalogue is always changing, the job of keeping both the original and the incomplete copy up-to-date called for much staff time, which had not been anticipated. The new copy of the shelf list is filed adjacent to the card catalogue and will serve as a kind of classified catalogue, particularly useful since the card catalogue has few subject entries.

Shelf-housekeeping continued the replacement of worn-out pamphlet folders and the provision of strong cardboard slip-cases for several score older books in leather binding. Several hundred volumes of little used unbound journals were provided with firm cardboard covers into which the several numbers of each volume were pasted. The neat and easily consulted books thus produced are much more easily kept clean and in order on the shelves than the thousands of loose fascicles.

Although no statistics are available, it is obvious that the use of the library has increased in the last few years; in particular, more people not on the staff or among the regular students are using the collections and inter-library loan requests have increased. The library has been able to meet these needs fairly well but the lack of convenient reading areas and the general crowding of the shelves are indications that more adequate quarters for the library are badly needed.

EDUCATION PROGRAMS

K. O. PECK
In Charge of Visitors' Activities

The activities of the Programs are under the direction of Kenneth Peck. He was assisted by Josephine Davies, who left in December to return to her home in England.

Children's Activities—The children's classes in 1960 were well attended in all phases. Some of the Saturday morning programs, such as Miniature Gardens and Christmas Decorations were attended by as many as 100 children, although the usual attendance on Saturday mornings was somewhat lower. A number of high school biology students participated in these classes for extra credit given them by their school instructors.

The Pitzman Summer Nature Program, in its third year, had 472 registrants for the two 5-week sessions

of classes. Approximately half of this number received certificates. As a part of the Pitzman Program, five groups of children were selected to form the Junior Research Teams. These teams investigated several matters of nature study. Details of these activities are described by Davies in the November, 1960 BULLETIN.

In October and November, about 600 children from three local schools visited the Garden to plant Paperwhite *Narcissus* bulbs which they were permitted to take home. As in the past, each child was given two bulbs and a period of instruction of what bulbs are and on how to grow them.

In addition to classes, over 130 tours were conducted for both children and adults as compared to only 90 tours in 1959. Late in 1960, most of the tours were in the Climatron which is the favorite tour attraction in addition to the floral displays. The Tree Trail, as usual, was exceedingly popular during the growing season. The Trail was changed this year and a new and fully illustrated guide sheet was given to all who requested it at the Main Gate.

Adult Courses — Clarence Barbre taught the courses for adults, consisting of Bulb Forcing, Plant Propagation and Spring Horticulture. Norton Nickerson, Robert Gillespie, George Bunting and Robert Dressler taught other courses in botany and horticulture.

Plans were made for a new program of adult instruction in Gardening and in Botany, with several new courses to be offered in 1961. See BULLETIN, January, 1961.

Other Activities—The preparation of many kinds of educational displays is one of the important functions of the Education Programs. Some of these displays were used in the Climatron and Floral Display House. Informative and identifying labels were prepared for some plants. A particularly fine set of signs for various lawn grasses and weeds was prepared by Paul Hale and Henry B. Lenhardt. About 80 people took part in a Sunday morning Grass Walk conducted by Edgar Anderson, George Van Schaack and Raymond Freeborg.

During the fall semester the Garden conducted a college botany course at the request of St. Louis Baptist College. Lectures were given in the Museum Building and laboratory sessions in the classroom of the Experimental Greenhouse. Robert Gillespie, Robert Dressler and George Bunting gave most of the lectures, while the laboratory work was supervised by Walter Hewitson.

CLIMATRON AND GREENHOUSES

LADISLAUS CUTAK, Horticulturist

The major project was the completion of the Climatron and subsequent landscaping of the interior in time for the official opening on October 1. As soon as the scaffolding was removed in early July, the removal of accumulated debris and dead palms was undertaken as the first step toward grading in preparation for actual landscaping. Walks were staked out, topographical features planned, water lines laid down and about a hundred tons of mushroom compost was incorporated into the soil. Most of the work was done by the regular Garden crew, although Rallo Contracting Company and Pring Landscapers were called in to do the heavy equipment work such as grading, moving tons of soil, digging holes for the specimen plants and hauling the huge palms into place. By the middle of August the Climatron was ready to receive the first plants. Thirteen large palms were set in place, and then actual planting began on August 17, and was completed in three days. These large palms—including two 25′ coconuts, two 30′ royals, one 35′ *Washingtonia* and several cluster palms came from Florida as donations, specifically from Fairchild Tropical Garden, the Jennings Estate, and the U. S. Plant Introduction Station at Chapman Field, Florida.

The specimen palms were root-pruned in March and were picked up in the latter part of May for transportation to St. Louis. It might be of interest to readers to learn that palm roots do not form new root-caps when injured or severed as in transplanting, so that new roots must be grown to sustain the plant. Palms, however, produce innumerable roots almost continuously, although during the winter months the root growth is comparatively dormant; therefore root pruning is advisable at that time. This gives the new short roots a chance to grow without disturbing their power to function. In the latter part of May, Lad Cutak and Al Mielczarek drove to Florida to prepare the palms for shipment to the Garden and to gather other plant material for the Climatron. The Lee-American Freight Lines of St. Louis dispatched a 40′ enclosed van to transport the palms, free of charge to the Garden. They did an excellent job and the plants arrived in very good condition, considering the warm windy weather prevalent during that period. To further protect the shipment, the palms were placed in the rear of the Flower House where boxes were built around their root balls and wood chips added to conserve moisture until actual planting was contemplated. By the time the Climatron was ready to receive the plams, the new roots had begun to burst hrough the burl

The men worked feverishly for long hours to meet the deadline, and by the time the grand opening became a reality, the project was worthy of their efforts and something of which to be proud. The bog area began to shape up nicely in early September,

and with the placement of Water Hyacinths and other aquatics, no one but the workers would suspect that the area planting was so recent. An eight-foot high "mountain" was slowly built and plants were established on its slopes. One will need only a vivid imagination to foresee what a startling feature this mountain will be when the plants reach their maximum size in the Climatron. Another outstanding feature is the waterfall whose water tumbles thunderously down the mountainside and drops to the lower levels. Actual work on the waterfall was begun on September 21, and in less than a week the project assumed a naturalistic aspect far beyond our expectations. It is now one of the big features for the visitors where many pictures are taken by shutterbugs. Feather rock (pumice stone) was used in the construction because of its light weight, and one large rock floats in the lower pool to the amazement of visitors.

The Hawaiian area was started on September 23 and includes plantings of *Hibiscus*, *Bougainvillea*, crotons and other showy plants that are generally cultivated in the Islands. In early October Cutak was sent to Longwood Gardens in Kennet Square, Pennsylvania, to pick up a van load of material, chiefly tree ferns. These are now forming a striking feature in the Hawaiian area and also as group plantings on the mountain and around the waterfall. In December Cutak went on a collecting expedition to South America.

The tropical waterlilies in the outdoor pools were left undisturbed until they were taken out on November 4. As usual, they produced a good show until late in the season.

FLORAL DISPLAYS

PAUL A. KOHL, Floriculturist

The annual orchid show, the first major floral display of 1960, opened with a preview for the Friends of the Garden on the evining of January 21.

Some *Camellias* bloomed in December and January, but February was the month when all of the plants in the Linnean house were bedecked with hundreds of flowers. Visitors from other parts of the United States are amazed at the size of our plants which can compare with those grown outdoors in the South. During the year our collection of *Camellias* was augmented by thirty-two varieties of cuttings and small plants shipped to us by the Descanso Gardens of La Canada, California. We also received from the Norfolk Botanical Garden, Norfolk, Virginia, one plant of the rare *Camellia granthamiana*, discovered in Hong Kong in 1955.

The African Violet Show, scheduled for March 5 and 6, was postponed to May 7 and 8. Members of Friends of the Garden were invited March 10 to meet the new officers of the association and for a preview of the Spring Flower Show of tulips and daffodils. The tulips came from Holland, and the 24 varieties of daffodils were donated by

Mr. Jan de Graaff of the Oregon Bulb Farms. The Easter display opened on Palm Sunday, April 10. Many kinds of colorful plants were used in this show, the *Azaleas* being the most spectacular.

The Daffodil Show, scheduled for April 9 and 10, was cancelled, as was the Spring Flower Show of the St. Louis Horticultural Society for May 14 and 15. The Rose Show of the Greater St. Louis Rose Society was postponed from May 21 to May 28. *Hydrangeas* were on display during June, and these were followed by *Caladiums* and other foliage plants. The first *Hemerocallis* show was staged on the balcony on July 9. The Illinois Gladiolus Society held its show July 24 and 25. *Cacti* were displayed September 3 through 11 by the Henry Shaw Cactus Society. The Greater St. Louis Harvest Show, sponsored by the Regional Council of Men's Garden Clubs of Greater St. Louis, was held September 17 and 18, and a week later, September 24 and 25, the Dahlia Society of Greater St. Louis staged its show in the flower house. The Veiled Prophet Queen's bouquet was on view October 5. The annual Chrysanthemum Show opened with a preview on November 3 and was followed in December by the Christmas display of *Poinsettias*.

Exhibits Away from the Garden or Unrelated to Flower Shows: The model of the Climatron was exhibited in the Mercantile Commerce Bank during the week of January 25. April 2 and 3 the Missouri Aquarium Society displayed tropical fish on the balcony of the floral display house.

April 24 was Flower Sunday at

The African Violet Show May 1960 PHOTO P.A.K.

Christ Church Cathedral, and for that event 200 plants were used to decorate the church for the Annual Flower Sermon, provided for in the will of Henry Shaw.

Marguerites were displayed in front of the St. Louis Chamber of Commerce building on Broadway for the Cleanup Campaign Week of April 25.

"Through the Garden Gate," a fund-raising project of the Women's Association of Shaws Garden, was held on the parking lot of Famous-Barr in Clayton, May 12 through 14. Four thousand annuals and perennials were supplied for this plant sale, and shrubs from the Experimental Greenhouse were also donated.

The St. Louis Aquarium Society held its show July 16 and 17. October 8 and 9 the Budgerigar Society of Missouri, Inc., held its Midwestern Regional Show in the flower house.

ORCHID COLLECTION

R. J. GILLESPIE, Orchidologist

Cultural Improvements—The installation of "Rain-Jet" automatic sprinklers, which were tried experimentally in 1959, was continued in 1960 so that at present all houses can be watered by this system when desired.

In the Spring of this year, a fertilizer proportioner was attached to the water main and a constant level nutrient feeding system was begun. This fertilizing provides a constant and complete fertilizer solution always present, at a predetermined concentration, in the water which is being applied to the plants. While it is much too premature to evaluate the effects of this program, numerous plants in the collection have made unusually large, robust growths during the past season indicating an improved environment.

Artificial Orchid Trees—An interesting aspect of the Orchid Department's work during the year was the development, under the personal supervision of Frits Went, of a group of artificial orchid trees. These trees were made by welding together numerous steel pipe segments to form a tree-skeleton, and then covering this skeleton with Osmunda fern fiber. Botanical orchids were then attached to the Osmunda in permanent position. The plants on each tree were collected from the same geographic area, and thus represent natural grouping. These trees are now located in the Climatron and the extent to which they have prospered in that environment is quite obvious, even to the inexperienced observer.

Orchid Show—The annual orchid show was held during the last week of January and during the entire month of February (Jan. 23–Feb. 28). The show consisted of a series of three orchid gardens, a California garden, an Hawaiian garden, and a Florida garden. Numerous hybrid *Cattleyas*, *Dendrobiums*, *Cymbidiums*, and *Cypripediums*, as well as a fine selection of the Garden's botanical orchids were staged in these gardens with an excel-

lent effect. A new "first" for the orchid show was achieved in 1960 by the staging of a table of miniature orchids illuminated under magnifying glasses, which enabled the public to observe the unusual colors and the intricate floral details of these plants.

Displays—A continuous display of orchids was maintained throughout the year in the Botanical Orchid House and in the alcoves until the opening of the Climatron in October. A new display area was constructed just inside the main entrance to the Climatron and another circular botanical staging was built and is now being used in the Climatron. Orchid cut flowers or plants were supplied weekly to the Shaw House and as usual, cut flowers were supplied by the Garden for the Veiled Prophet Queen's bouquet.

A number of Orchid plants and flowers were also given to various deserving individuals and institutions during the year. A selected group of the Garden's orchid plants were used in driftwood displays in Famous-Barr's Clayton store during the May Garden-Gate benefit sale by the Women's Association.

Accessions—New introductions into the orchid collection (some 900 entries) were particularly noteworthy during the year 1960. Many new species of botanical orchids, chiefly from South America, were added to the collection. One particularly valuable accession was a collection of selected Ecuadorian specie orchids which was donated to the Garden by Cal Dodson, formerly Director of the Botanical Institute, University of Guayaquil, Guayaquil, Ecuador, and now on the Garden Staff as Research Associate. Another interesting and valuable group of orchids from Indonesia was acquired for the Garden by Frits Went. This material adds some plants to the collection from an area from which the Garden had had only a few representative species.

Research and Instruction—The potting medium experiment involving a block of *Cattleya Mrs. John S. Lehman* was concluded (see BULLETIN for October, 1960). In addition, several articles were published during the year by the Orchid Department in national orchid publications. Four courses on orchid culture were given and were well attended and received.

In May, Robert Gillespie had the privilege of being sent to London, England, to represent the Garden at the Third World Orchid Conference. In addition to attending the Conference, Gillespie also visited numerous horticultural concerns and botanical gardens, both in England and on the Continent. The Orchid Collection also participated in the Mid-America Orchid Congress which was held in November in Chicago, Illinois, by assisting in the lecture program and in judging of the orchid show.

GROUNDS AND MAINTENANCE OPERATIONS

LOUIS G. BRENNER, Grounds Superintendent

The increased visitor attendance during the past year, largely induced by the completion of the Climatron, thoroughly tested the abilities of the Grounds Crew who were able to cope with the multitude of problems stemming from increased area usage yet were able to add a considerable number of man-hours toward completion of the Climatron display area.

Few new trees and shrubs were planted on the grounds this year because of constructional features imposed by the Master Plan of the Garden. However, several unusual specimens from the small nursery at the Experimental Greenhouse were planted into the Grounds.

The Webster Groves Men's Garden Club, under the direction of Mr. Dan O'Gorman, organized a volunteer group from this club and again provided Dahlias and Cushion Chrysanthemums for a fine blaze of color in the Knoll area. These men provided hours of patient labor toward propagating and planting this fine display.

The Rose Garden continued as a major summer and fall display, providing an outstanding attraction to visitors who delighted in viewing the best of the new varieties and outstanding experimental hybrids of some of the nation's great rose breeders, with whom the Garden cooperates in displaying most recent creations. Outstanding in the Rose Garden this year were Duet by Armstrong Nurseries Inc., Peach Glow by Jackson and Perkins Co. and Coronado by Peterson and Dering. The continued excellence of the summer rose display was possible largely through the efforts of Mrs. E. F. Stuessie and members of Webster Groves Garden Club Group 4 who volunteered many hours toward light summer pruning and clipping faded blooms in the Rose Garden.

The lawns of the Garden continue to improve. Large scale use of selective weed killers and other herbicides has made relatively light work of the seemingly great chore of lawn maintenance. In October a light dressing of fertilizer was applied to the lawns with the new cyclone type spreader purchased recently. With this unit added to the maintenance inventory it is now possible to apply frequent light dressings of fertilizer under ideal weather and soil conditions, important to good lawn maintenance.

As mentioned above, the Grounds Crew played an important role in the completion of the Climatron where they were responsible for removal of the mass of litter left by the many contractors; hauling and tilling compost into the soil prior to planting; planting of large new palms; constructing walks; aiding in planting the multitude of exotic tropical plant species; and moving and placing the large pumice stones at the base of the waterfall. The dashing mountain brook and ledge of the waterfall were built by Jess Mayhan and George Hochrein, who also repaired the columns retained from the old Palm House. Together they also recondi-

tioned the east ends of the Cactus and Succulent Houses isolated now through removal of the Economic and Fern Houses. Grounds crewmen managed to win the race with time by successfully grading the ground in front of the Climatron, and producing a "fuzz" of new lawn by Dedication day.

The Grounds Operations also maintains the grounds of the National Council of Federated State Garden Clubs through a special cooperative agreement.

Building maintenance included redecoration in early spring of the "Friends of the Garden" and Main Gate offices. Sales facilities in the Main Gate office were greatly improved by the addition of cabinets and pegboard display panels. Main Gate facilities were further improved by the introduction of a See-Thru map designed and built by the Ground Department. This installation also includes a bulletin board of Garden attractions keyed to appropriate locations on the map. During the summer two of the growing houses of the Floral Display Department were reconditioned by replacing ridgecaps and renovating the ventilator sash. Late in the year major repairs and redecorating were begun in the Main Gate restrooms. The Ground Operations continued to work closely with the Historical Committee of the Garden in restorative work at the Shaw House, and the Mausoleum, by doing much preliminary work in preparation for the many special craftsmen called on for restorative repairs.

ENGINEERING OPERATIONS

KENNETH A. SMITH, ENGINEER

THE background operations of the Garden providing heat, water, electrical services and the maintenance of equipment for all other branches has been performed under the direction of Kenneth Smith, Engineer, and James Hampton, his Assistant.

In addition to the regular operations, these men have assisted with the problems connected with the opening and operation of the new Climatron. These items include waterlines on both levels, installation of pump, piping and some concrete work for the waterfall; light shields for floodlights, and assembly, wiring and erection of the central light fixture. The framework for the artificial trees was welded by Hampton as a special project. Considerable time was required of these men to work with the various contractors, such as Minneapolis-Honeywell, in their installations of devices and special mechanical equipment for automatic controls in the Climatron.

The heating plant required a new refractory arch in No. 2 boiler. The boiler feed lines were replaced in the pump room.

Other operations about the Garden included new water lines in the Curiosity House; new furnace for the Main

Gate offices; spotlights for the Floral Display House and the Linnean House; additional wiring for the Shaw Home; and experimental equipment for use of research workers in the Experimental Greenhouse.

ARBORETUM

FRANK L. STEINBERG, SUPERINTENDENT

THE Arboretum continues to be managed with a skeleton crew, yet the roads have been kept open, the grasslands managed and pruning and clearing continued. The area about the Pinetum Lake is open to cars daily, The longer drive past the dogwoods, redbuds and many drifts of naturalized daffodils to the trailhouse and wildflower trails was kept open for six weeks in April and early May.

Mowing required 727 tractor and man hours. The Pinetum was mowed in the late Spring and again in the Fall. All planted groups in the Pinetum were cleared of brush and sprouts, and dead trees were removed. All the groups are clean and this should help the daffodil display in the Spring. Mowing 120 acres on the farm required 108 tractor and man hours.

Guard rails on all the bridges were cleaned and painted. Minor repairs were made to the roof and gutters of the old brick residence. Brenner's residence also required minor repairs. The Gate House was repainted.

INFORMATION CENTER

THE Main Gate offices were repainted, new shelves, peg boards and a new heating system installed to serve the Information Center and for offices of the "Friends of the Garden" organization. The sales of books, pamphlets, correspondence and general public information are served by Mabel Shepherd during the weekdays, and by Trifon von Schrenk and Jess Mayhan on weekends and during evening hours. George Pring answered numerous requests for information, appeared on radio and television programs and gave a number of lectures. He represented the Garden at the Third Orchid Conference in London, England. He visited the Oxford and Cambridge Botanic Gardens and spent a week of study in the herbaria of Kew Gardens and British Museum on research in the *Nymphaeaceae* to find new species that might be useful in future breeding work at the Garden. He spent three days at Floriade (Floricultural Exhibition) in Rotterdam, Holland. He visited the Gubler Greenhouses in Zurich, Switzerland, which specializes in orchids and foliage plants.

The new and improved Information Center with its enlarged and improved selection of books, pamphlets on plants, and souvenir items is attracting a larger number of visitors.

MISSOURI BOTANICAL GARDEN PROGRAMS

Special Shows and Displays

Bulb Show, March 5 through 19
Easter Display, March 26 through April 2

Free Nature Programs for Children, aged seven and over, are held every Saturday morning from 10:00 to 11:30 A. M., Museum Building.

March 4 Three Cheers for the Green Thumb
(you may take your plants home)
March 11 The Secret Life of a Plant
March 18 The Story of the Pincushion Forests
March 25 Make Your Own Dwarf Garden
(bring your own container)

Courses for Adults. Beginning in March

104 How to Propagate from Seed. (Two Sections). 5 Sessions, Fee $12.00.
Tuesdays, March 14 and 21, April 4, 11 and 18, 1:00 to 2:30 P. M.
Thursdays, March 16 and 23, April 6, 13 and 20, 8:00 to 9:30 P. M.

Fundamental facts and procedures for producing annuals, biennials and some perennials from seed for use in your garden. The Garden supplies seed, germinating media and soil for four metal flats of seedlings which you may take home. Persons wishing to supply their own seed must bring it to the first session. Instructor Clarence Barbre.

206 Economic Botany. 5 sessions, Fee $10.00
Wednesdays, March 15 and 22, April 5, 12 and 19, 8:00 to 9:30 P. M.

General instruction in useful plants and their relation to man are studied, using the Garden's extensive collections of materials from archeological sites, primitive culture and modern breeding experiments. Instructor Hugh Cutler.

A SERIES OF LECTURES ON RESEARCH AT THE GARDEN.

Given the First Monday of Each Month

"The Evolution of Some New World Plants"
Dr. Hugh Cutler, March 6, 8:00 P. M., Museum Building.

"Orchid Hunting in South America."
Dr. C. H. Dodson, April 13, 8:00 P. M., Museum Building.

Dr. Dodson, Taxonomist and Research Associate in the Herbarium, assisting in the preparation of the Garden's "Flora of Panama."

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SOME FACTS ABOUT SHAW'S GARDEN

The Missouri Botanical (Shaw's) Garden was established in 1859 by Henry Shaw, a St. Louis businessman, to be controlled by a Board of Trustees for the public benefit. The Garden is a non-profit institution which receives no support from the city or state, depending on the income from the Shaw estate supplemented by contributions from the public.

The old stone walls and cast-iron fences, the Linnean House, the Museum Building, the part of the Administration Building which was Shaw's Town House, relocated in the Garden in 1890, and the Tower Grove House, his country home, all date from Mr. Shaw's time. The Main Gate, display and growing greenhouses and most other facilities date from the period immediately following the turn of the century. The Climatron, opened in 1960, is the first of several new buildings planned for the Garden's redevelopment. It is the world's first geodesic dome, fully climate-controlled greenhouse and contains the Garden's tropical collections.

The Garden—70 acres—is open every day of the year (except Christmas and New Year) from 9 A. M. until sundown, the greenhouses 9 A. M. to 5 P. M., the Climatron Monday through Thursday 9 A. M. to 5 P. M., Friday through Sunday 9 A. M. to 9 P. M. Tower Grove House is open daily from 1 P. M. to 4 P. M. (December to March on weekends only). The Display House presents four seasonal displays: November, Chrysanthemums; December, Poinsettias; February, Orchids; Spring, Lilies and other flowers. During the year are other shows, competitions and festivals sponsored by various Garden Clubs and Flower Societies.

Courses in Botany and Horticulture for adults are conducted by the Garden staff. Children's nature studies are provided each Saturday of the year and a special nature program is held during the summer. Information on these activities is published in the BULLETIN or may be had by mail or phone. The Garden maintains a research program through the Henry Shaw School of Botany, Washington University.

In 1926 an Arboretum — 1600 acres — was established at Gray Summit, Missouri. Foot trails and roads pass through the Arboretum and are open to visitors in April and May.

The Garden Administration Building is located at 2315 Tower Grove Ave., and the Garden main entrance is at Tower Grove and Flora Place. The entrance at Tower Grove and Cleveland Avenue is also open to the public. The Garden is served by both the Sarah (No. 42) and the Park-Southampton (No. 80) city bus lines.

Persons interested in helping to support the Garden and taking part in Garden activities are urged to do so through the "Friends of the Garden". Information may be obtained from the Main Gate or by mail or phone.

MISSOURI BOTANICAL GARDEN

Bulletin

April 1961
Volume XLIX
Number 4

COVER: The Dandelion. A maligned member of the Aster Family except for those who appreciate its "blossom wine" or the "greens." All drawings by P. A. Duke

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Missouri Botanical Garden Bulletin

Vol. XLIX No. 4 April 1961

APRIL ASTERS

JAMES A. DUKE

ASTERS are members of the largest family of flowering plants, a family entitled the composite family or Compositae. This family, and especially the aster, are responsible for the burst of color in autumn, at which time they offer their most magnificent display. Although the true asters are absent from the April flora of Missouri, a few close relatives begin to flower in April, and some of these can be found in March on occasions, especially near cities, where the temperatures are more amicable.

Numbering about a thousand genera, the composite family is a very diverse and widespread group, many of which occur naturally in Missouri. There is almost an equal number cultivated as ornamentals. Among the more familiar ornamentals are anthemis, chrysanthemum, cineraria, coreopsis, cosmos, dahlia, gerbera, marigold, sunflower and zinnia. Of importance as edibles are lettuce *(Lactuca)*, endive *(Cichorium)*, salsify *(Tragopogon)* and the globe artichoke *(Cynara)*. Not to be forgotten are the nuisance members such as the goldenrod, ragweed, dandelion and cocklebur. A few, such as chicory, tansy, costmary, and southernwood, are used as spices and often find a place in the herb garden. It is hoped however that this article will serve to familiarize you with those few Missouri species which begin flowering in April.

The botanical name Compositae is not without significance. How many of you have seen a child dissecting a daisy, repeating, "she loves me; she loves me not"? Many would assume that the child were stripping the daisy of its petals, but the process is more complicated. The composite or aster family, as it is commonly called, is so named because the "flower" is in reality a complex aggregation of several, even hundreds of flowers, grouped together on a common receptacle to form the composite structure known botanically as the *head*. So when the child strips the daisy "flower" of its "petals," he is actually stripping the *head* of several of its constituent flowers.

With this in mind, let us examine more closely the "flower" of the robin's plantain (Fig. 1), one of the earlier composites to flower, and the one superficially most closely resembling the aster. At the same time let us compare it with the true flower of the spring beauty (Fig. 2), a member of the portulaca family, which can be found blooming at the same time as the robin's plantain. The outermost whorl of the spring beauty flower consists of two greenish structures, the

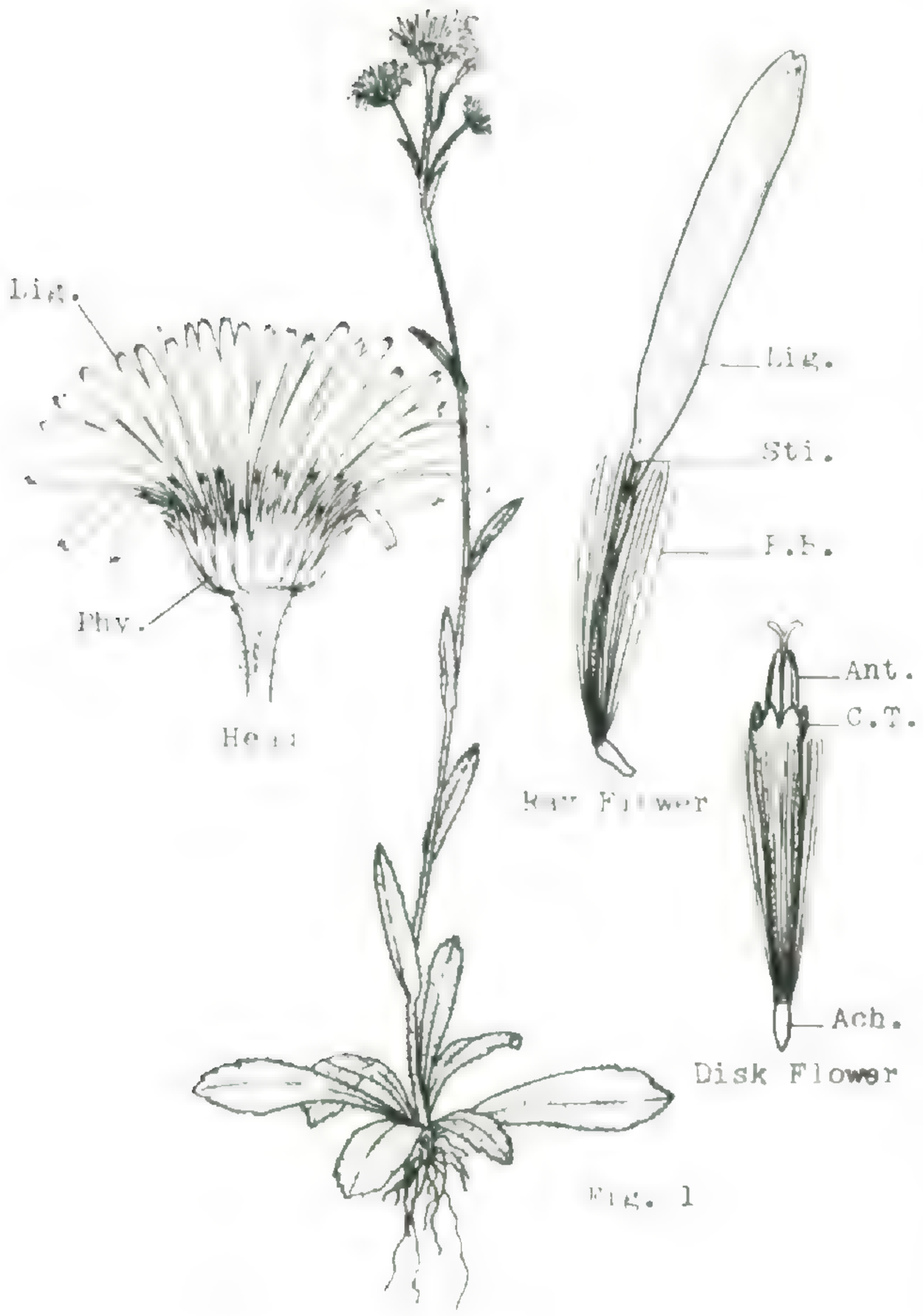

Fig. 1

sepals, which are almost round. Inside these are five pink petals, which are longer and narrower than the sepals. Inside the petals are five stamens, which consist of narrow elongated stalks, the *filaments*, (*fil.*) at the tip of which are the anthers (*ant.*), which are yellowish to pinkish and which produce the pollen. The anthers somewhat resemble a football in shape, and upon closer examination are seen to be divided into four quarters. In the center of the flower is the ovary, a globular structure which at maturity will produce about five seeds. At the tip of the ovary is a long stalk, the style (*sty.*), which towards its apex, divides into three short papillate branches (*sti.*), the *stigmata* (sing. *stigma*), to which the pollen is transferred when pollination is effected. On most plants of the spring beauty

several flowers will be observed. The collective name for the flowers and the branches upon which they are borne is the *inflorescence*. If we could visualize the condensation of the inflorescence so that all the branches and stalks had fused, we would have visualized something close to the composite inflorescence which is called the *head*.

Outside the head of the robin's plantain is a whorl of green structures, the phyllaries (phy.), which resemble the sepals of the spring beauty somewhat but in reality correspond to its uppermost leaves. In the center of the head of the robin's plantain we will find several minute flowers, which will show several similarities with the larger flowers of the spring beauty. The outermost whorl of this flower,

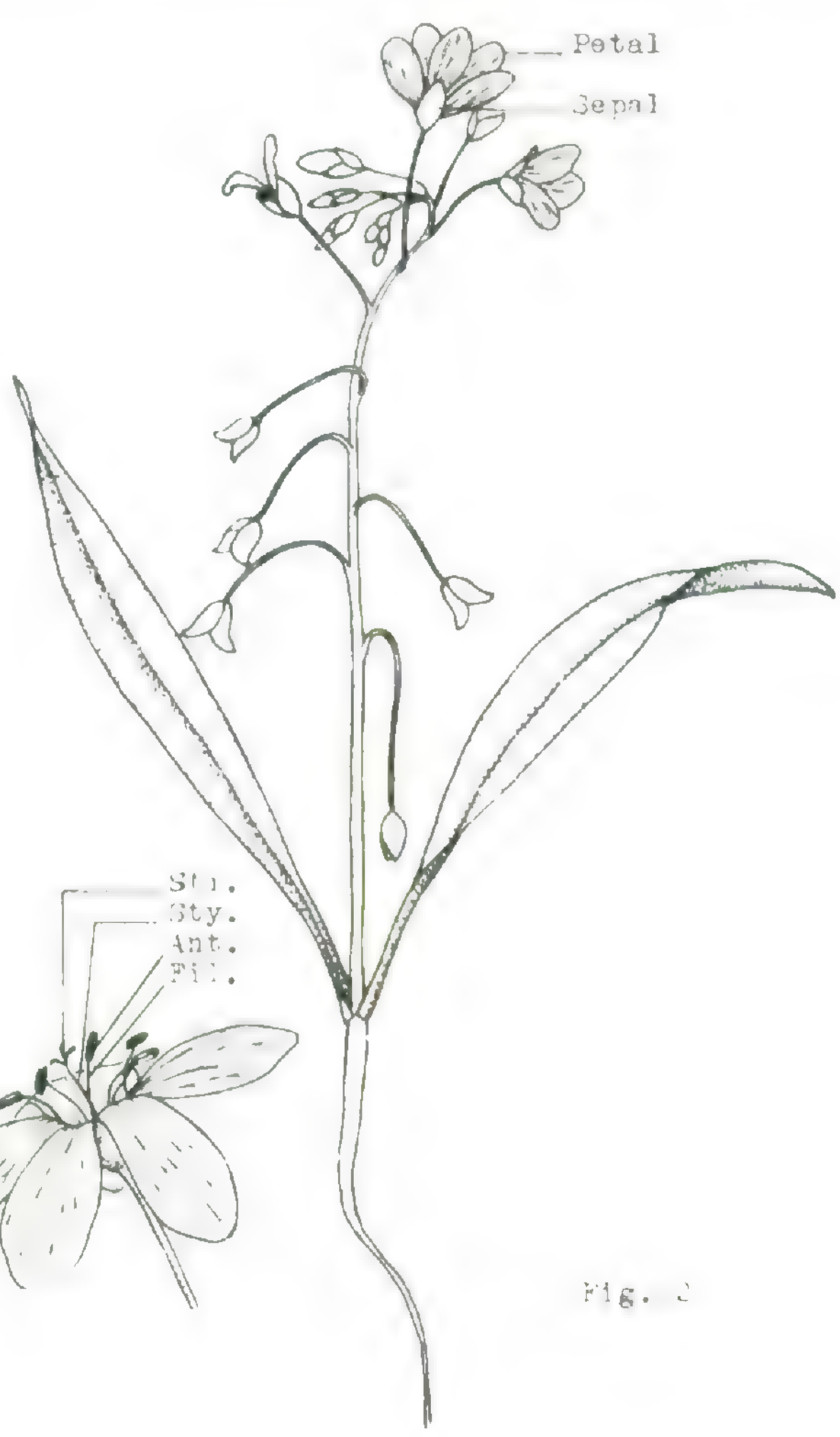

Fig. 2

known as a disk flower, consists of several threadlike bristles, the pappus bristles (*p.b.*) which collectively form the pappus. Although the similarities are remote indeed, the pappus bristles correspond to the sepals (*sep.*) of the spring beauty. Inside the pappus bristles we find a five-lobed tube, the corolla tube (*c.t.*), which corresponds to and more closely resembles the petals of the spring beauty. The petals of the composite have grown together at their base, somewhat like the toes of a duck. The five lobes of the disk flower show vestigially the relationship to the five separate petals of the spring beauty. Inside the corolla tube and scarcely visible to the naked eye are five stamens, the tips of which barely emerge from the tube of the corolla. The stamens also show a tendency toward coherence. Their anthers (*ant.*) have grown together to form a second tube inside the corolla tube. The ovary of the disk flower is completely enclosed within these two tubes and can be located only by dissection, but it will be found to be quite similar to that of the spring beauty, except that it has become fused with the basal portion of the pappus and the corolla tube (*c.t.*). Furthermore, the style has only two stigmata (*sti.*), rather than three as in the spring beauty. The ovary in the composite family forms only one seed and that, inextricably fused with the lower portion of the pappus, is known as the achene (*ach.*). Since there are several flowers in a head, several achenes are normally produced, and the pappus bristles, which usually remain attached to the achene, often aid in their dispersal.

This is merely half of the complicated story of the composite flower. We have studied only the disk flowers which are at the center of the head. At the periphery of the head are more flowers, constructed on a slightly different pattern, and showing even less resemblance to the flower of the spring beauty. These outer flowers, known as *ray flowers* or *ligulate flowers*, have pappus bristles similar to those of the disk. The corolla tubes, however, are very one-sided or asymmetrical, and the outer conspicuous sides form strap-like structures, the rays or ligules (*lig.*), which are usually the most striking feature of the composite flower. To the uninformed these are the "petals" of the daisy. Embraced by the asymmetrical corolla tube of each ray flower are a style and 2 stigmata (*sti.*), similar to those of the disk flower, but the stigmata are visible toward the interior of the ray flower (see figure 1 *sti.*). Stamens are lacking in the ray flowers, which are thus unisexual (female), as contrasted to the bisexual disk flowers.

This brief introduction to the composite flower may serve to explain why many naturalists, as well as amateurs, tend to avoid and pass by the numerous and sometimes quite attractive members of the composite family. Due to their complexity and multiplicity, the family is a difficult one to master in a short time. Variability might be added to the list of characteristics of the composite family. We have come to find that the so-called flower is actually a head, an aggregation of several flowers, and in a single head are two quite different types of

flowers, the symmetrical disk flowers toward the center, the "eye" of the ox-eye daisy, and the asymmetrical ray or ligulate flowers toward the periphery, the "legs" of the spider chrysanthemums. This arrangement is only one of many variations on the composite theme. In some genera all the flowers in a head are symmetrical (discoid) while in others all are asymmetrical (ligulate). In some genera all flowers are of one sex on one plant and of the opposite sex on another; in others, the inner flowers in a given head may be of one sex, while the outer may be of the other, or completely asexual; converse relationships also exist. In some plants, the heads are themselves aggregated into compound heads. To describe the variables and their combinations would be tantamount to describing the thousands of species of composites, a monumental task. Let us limit ourselves for the present to a basic understanding of the composite head, and at the same time familiarize ourselves with the seven genera which bloom in April here in Missouri.

One of the best tools for plant identification is the dichotomous key, which works by offering two alternatives. A series of couplets are contrasted, alternate members of the couplet bearing the same letter. To identify your plant, read each member of the couplet; only one will apply to the plant you are identifying. Following the applicable member will be either a letter which directs you to the next couplet or, if you have beginner's luck, the name of your plant. One should pursue the couplets until he arrives at the name of the plant. Then the plant is no longer a mystery but an addition to the list of "wildflowers I have known." April has few composites, and the fewer the alternatives, the easier the key. Why not pick the first composite you see this month and try to identify it with the key. And remember, if the first *a* does not apply to your plant, proceed to the second *a*. In case the key fails you, brief descriptions and helpful illustrations follow the key. You will find it more rewarding to use the key first and corroborate your identification with the illustrations, but you may find it a trifle easier to pass the key and identify by means of the illustrations.

KEY TO APRIL-FLOWERING COMPOSITES

a. Plants without milky sap; some or all flowers without ligules. (Proceed to *b* if this is true of your plant; to the alternative *a* if untrue).

b. Ligules yellow—Squawweed *(Senecio)* (1)

b. Ligules not yellow, sometimes completely absent (proceed to *c*)

c. Heads without ligules ("petals")—Pussy Toes *(Antennaria)* (2)

c. Heads with white or lilac ligules (proceed to *d*)

d. Stem leaves less than 1/8 inch broad; pappus with only 5 bristles — *(Chaetopappa)* (3)

d. Stem leaves at least 1/4 inch broad; pappus with many bristles — Robin's Plantain *(Erigeron)* (4)

a. Plants with milky sap; all flowers ligulate (proceed to *e*)
   e. Achenes without pappus bristles at the top—*(Apagon)* (5)
   e. Achenes with conspicuous bristles at the top (proceed to *f*)
      f. Leaves merely toothed; heads ¼ to 1 inch broad; pappus bristles emerging from top of achene — Dwarf Dandelion *(Krigia)* (6)
   f. Leaves deeply lobed; heads at least 1 inch broad; pappus bristles on a stalk emerging from the top of the achene— Dandelion *(Taraxacum)* (7)

1. *Senecio,* Squaw-weed, Ragwort (Fig. 3). Characterized by the bright yellow ligules and the leaves which are often egg-shaped, this large genus has several species expected to bloom in April. The silky bristles on the achene are numerous and lack the stalk so characteristic of the dandelions. Were it not for the lack of milky juice, this could conceivably be confused with the dwarf dandelions. In the dwarf dandelion, by means of contrast however, every flower in the head has a ligule, whereas in the squaw-weed only the outer flowers have the ligule. *Senecio* is one of the largest genera in the composite family, and classification of the species is very involved. The butter-weed, *Senecio glabellus*, differs from the others in having no basal leaves, or in having the basal leaves, when present, deeply lobed, the lobes extending almost or completely to the midrib of the leaf. The golden ragwort, S. *aureus*, is characterized by having all or most of the basal leaves shaped somewhat like a valentine. Bruising the upper leaves and phyllaries will often yield a peculiar and delicate odor. *Senecio plattensis*, the prairie ragwort (Fig. 3), and S. *pauperculus*, two closely related species of the prairies and glades, both have leaves which are tapered to the base and often (at least in S. *plattensis*) have a characteristic wooly appearance. These species lack the delicate odor in their phyl-

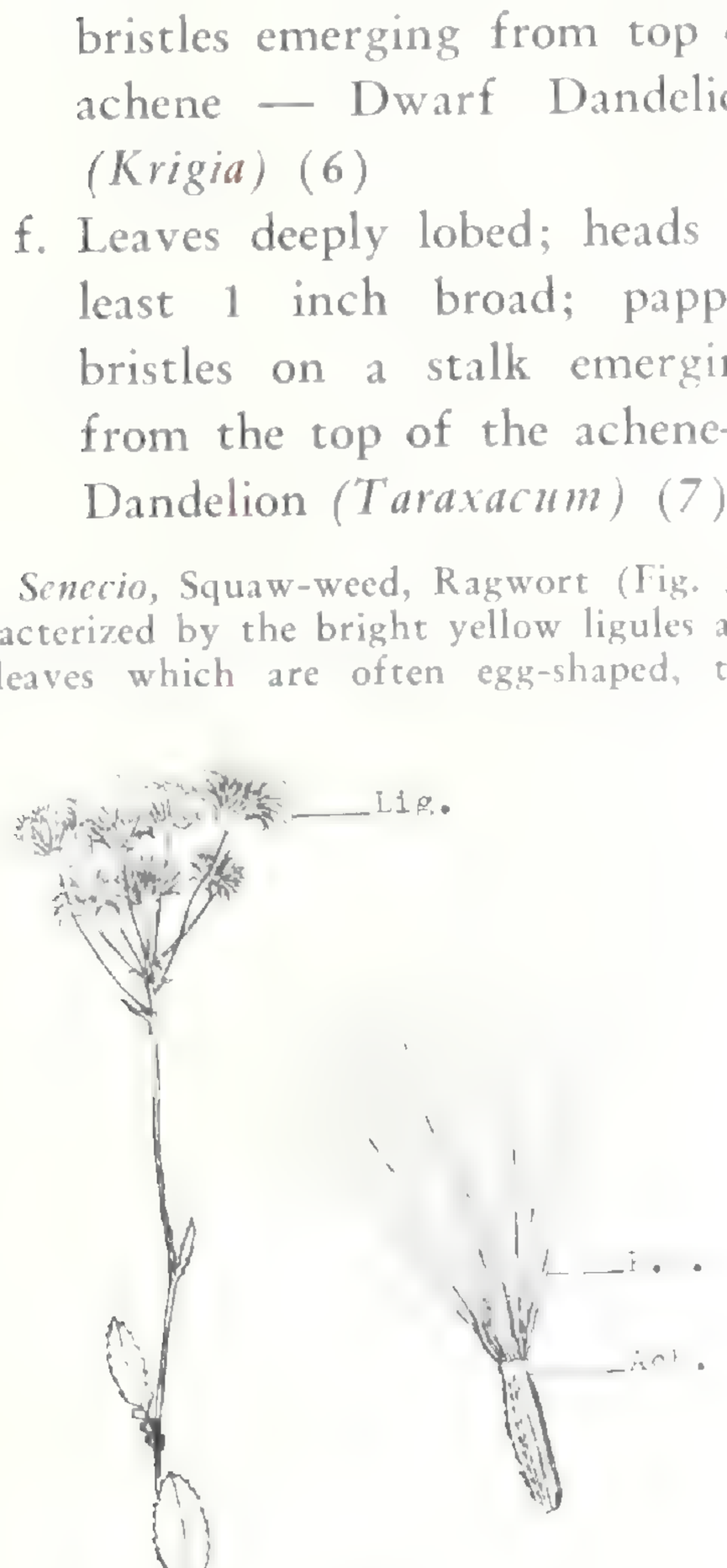

Fig. 3

Fig. 4

Fig. 5

laries. Another closely related species, *S. obovatus*, has spoon-shaped or nearly round leaves which are not woolly. It is further differentiated from the preceding by producing runners somewhat like a strawberry.

2. *Antennaria*, Pussy Toes, Everlasting, Ladies' Tobacco (Fig. 4). Pussy toes stand out from other early-flowering composites in that they have no ligulate flowers, i. e., all the flowers are discoid. The distinctive silvery cast of the flowers, rivaled by the pussy willow, also occurs on the stem and leaves. The basal leaves persist throughout the winter. In some plants all the heads are male and in other plants, all are female; the female plants are usually more robust. Three species flower in April. In *Antennaria neglecta*, the female of which is illustrated in Fig. 4, the basal leaves have only one rib. Of the other two species, both of which have three ribs in the basal leaves, *A. plantaginifolia* has phyllaries less than $^{5}/_{16}$ of an inch long, while *A. fallax* has the phyllaries longer. Picked at the right stage (before the fruits have fully matured), the plants are nice for dry floral arrangements, and persist for some time. This explains the common name "Everlasting."

3. *Chaetopappa* (Fig. 5). As in *Zinnia*, *Dahlia*, *Cosmos* and several other genera, the Latin name is most commonly used for this genus, represented in Missouri by one species, *Chaetopappa asteroides*, which is not very common. The plant is rather inconspicuous with small narrow leaves. The color of the rays varies from white to lilac, as do those of the robin's plantain, which however has numerous and conspicuous silvery pappus bristles. The pappus of *Chaetopappa* has only five bristles (*p.b.*) although there are some minute scales (sca.) intermixed with them.

4. *Erigeron* (robin's plantain) (Fig. 1). The robin's plantain is the first of the Erigerons to bloom in spring, and it is probably the most attractive of them, closely resembling the true *Aster* of autumn. Since it was discussed in the explanation of the composite flower, there is little to add except to call attention to the numerous pappus bristles which, as in many composites, are responsible for the widespread dispersal of the seeds. The leaves are rather hairy but not so attractive as those of *Antennaria*. Robin's plantain is more common in southern than northern Missouri.

5. *Apogon* (Fig 6). Apogons are closely related to the dwarf dandelions (and included in the genus by recent taxonomists). The differences are rather technical and they are rarely observed by the amateur; hence the Apogons seem also to have acquired no colloquial names in Missouri. The genus is represented in Missouri by only one species, *Apogon oppositifolia*. As the name implies, the leaves on the stem arise in pairs, with one member directly opposed to the other at a given point

on the stem. These dwarf plants are characterized by the milky sap exuded when the stem is broken, and furthermore by a waxy, bluish coating on the leaves which may be rubbed off with the finger. The long leaves are asymetrically toothed as a rule, although many leaves on a given plant may be quite smooth-edged. Leaves of many composites often exhibit such an array of variation that the only adjective that can be surely applied to them is *variable*. The heads consist of about 20 florets, each of which has a yellow ligule (*lig.*). On the uppermost part of the floral stalk just below the head may often be found a tufted ring of toadstool-shaped hairs, scarcely visible to the naked eye. These also occur in some of the dwarf dandelions. The achenes (*ach.*) usually lack the bristles so characteristic of the dwarf dandelions however. Apogons are more common in the southern part of the state.

6. *Krigia*, Dwarf Dandelions (Fig. 7). Of the four species of *Krigia* expected in the April flora of Missouri, only one, *Krigia biflora*, has leaves on the stem as does *Apogon*, but the flowers of *K. biflora* are much larger than those of the Apogon. Of the dwarf dandelions the easiest to recognize is *K. dandelion*, which has a bulbous root sometimes an inch in diameter [see Fig. 7 (*bul.*)]. The flowers of *K. dandelion*, as those in *K. biflora*, which lacks the bulbous root, are nearly as large as those of the true dandelions. The two remaining spring-flowering dwarf dandelions have smaller flowers, and the characters separating them are difficult to discern with the naked eye. Each head of *K. occidentalis* has eight or fewer triangular phyllaries with a prominent midrib. In *K. virginica* there are nine or more phyllaries and they are very narrowly triangular, approaching the grass blade in their proportional dimensions. These four species of *Krigia* are more common in the southern part of the state.

7. *Taraxacum*, Dandelion (see cover). The dandelion is probably as well known as any of the Missouri weeds, and it is nearly as infamous as crabgrass. But since this is our first lesson in composites, let us take a closer look at this culprit. The outer green structures on the head are the phyllaries. In the red-seeded dandelion (*Taraxacum laetigatum*) they are constricted at the tip like a tenpin, whereas they are rather evenly drawn out to the tip in the common dandelion (*Taraxacum palustre*). In early spring the whole interior of the flower-head is bright yellow. Examination shows that the yellow belongs to the strap-shaped ligules (*lig.*), each ligule representing one floret. Later in the season the yellow will disappear after the florets have matured, and each will be represented by a single achene (*ach.*) which, in the red-seeded dandelion, is reddish-brown, and in the common dandelion is olive-brown. At the top of the seed on a long and conspicuous stalk are the ends of the pappus bristles, the whole pappus resembling the skeleton of a broken umbrella, and these seeds can be carried for miles by the wind as a result of this parachute-like construction of the pappus. So if lawns are your interest, and you consider the dandelion a pest, or if wines and greens are your interests, and you consider the dandelion an epicurean godsend, why not examine the flower more closely? There is more there than meets the unobservant eye.

THE STRUCTURE OF THE ORCHID FLOWER

ROBERT L. DRESSLER

THE remark is frequently heard that the iris flower is "just like an orchid." Of course, such a statement comes only from someone who is not very observant. But how can we compare an orchid flower with more ordinary flowers? It is difficult to see stamens and pistils in the flower of an *Odontoglossum* or a *Vanda*, yet these *are* truly flowers, and they have evolved from more ordinary flowers in the course of geological time. There is much that we do not know about the evolution of the orchid flower, but what is known is enough to make a fascinating and enlightening study.

The orchid family belongs to that major division of the flowering plants which the botanist calls the "Monocotyledoneae," or simply, the monocots. These plants have their parts in three's (rather than four's or five's), and so it is this basic plan which we expect to find in the orchids. We may conveniently compare the orchid flower with the lily or the amaryllis, which are rather typical monocots. The lily flower has all of its parts in sets of three—two sets of three petals, two sets of three stamens, and one three-parted pistil. Interestingly enough, these sets show a regular, geometric alternation from the outside of the flower to the center (see figure 1).

THE DISTINCTIVE FEATURES OF THE ORCHID FAMILY

If we study only the most complex and highly evolved orchids, we could find any number of features to distinguish them from other plants. However, if we take the whole orchid family, including some of the small-flowered species which are scarcely ever cultivated, it becomes much more difficult to "define" the orchids. Some of the more primitive orchids have flowers which are really very much like those of other plants. Of the several features listed below as characteristic of the family, only three of them are found in all orchids. Since any one of these features may be found

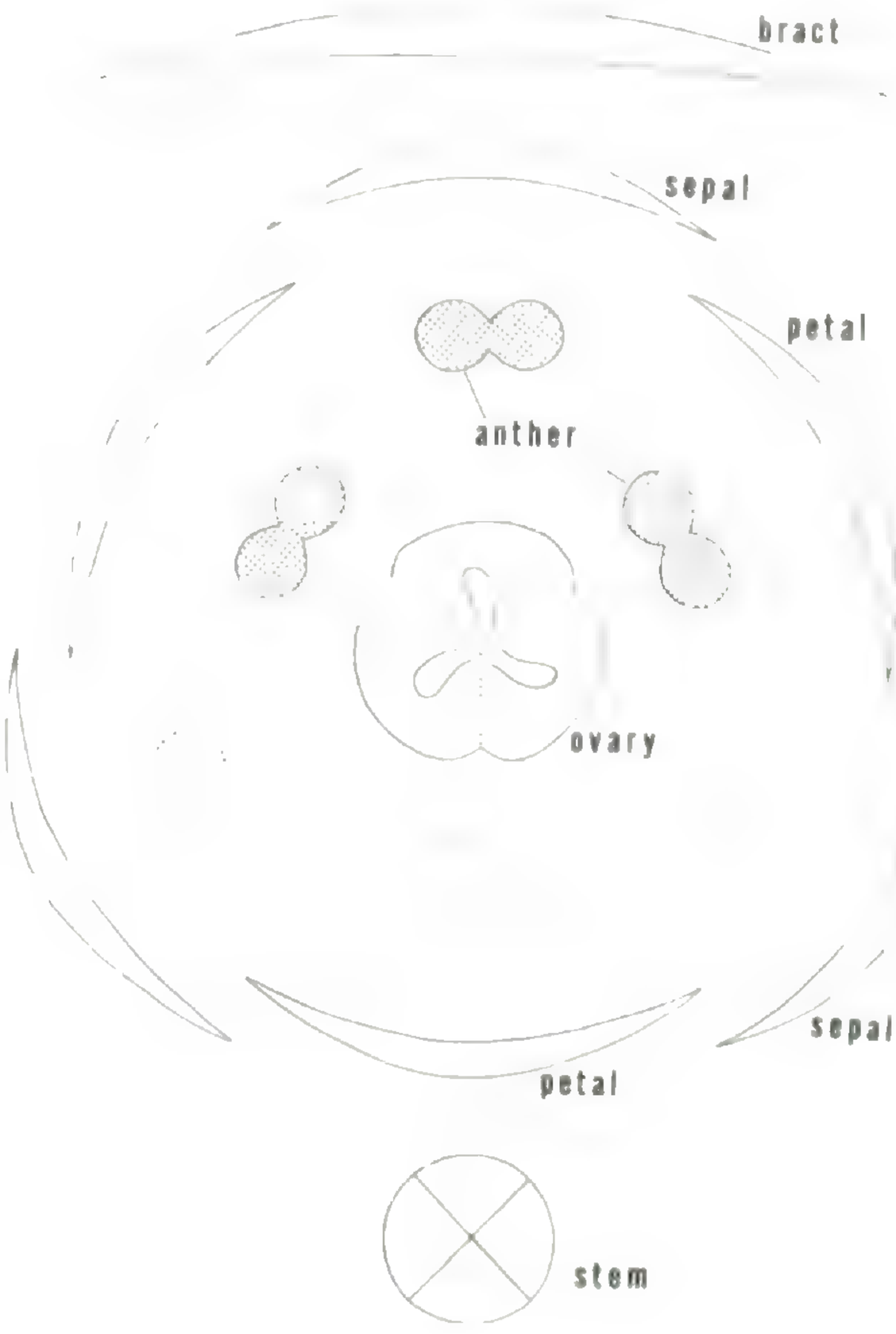

Figure 1. Diagram of a monocot flower, showing the parts which are present in orchid flowers. The petal which is next to the stem in bud becomes the lip in the orchid flower. Two of the anthers of the outer set and one of the inner set (here shown by dotted lines) are never developed in normal orchid flowers.

in other kinds of plants, it is really the combination of features which indicates an orchid, rather than any one "key" feature.

1. The stamens are all on one side of the flower, rather than being symmetrically arranged.
2. The stamens and pistil are at least partly grown together.
3. The seeds are tiny and numerous.
4. The flower usually has a lip.
5. The flower usually twists around in the course of development.
6. Part of the stigma (the rostellum) is usually involved in transferring the pollen from flower to flower.
7. The pollen is usually bound together in few large masses (which may be either soft or hard).

This listing of the features which are distinctive for the family does not begin to outline the complexities of orchid structure. So let us consider each part of the orchid flower in greater detail, starting at the base and working upwards through the column.

Ovary

In the lily flower we find a three-parted ovary in the center of the flower, and this develops into a capsule when the flower is pollinated. In the orchids the capsule appears to develop from the stem beneath the flower. In some distant ancestor of the orchids the bases of the sepals, petals and stamens grew to the ovary to an ever increasing degree,* until these parts seem to be attached above rather than beneath the ovary. The ovary which is beneath the flower and covered by a sheath of sepal, petal and stamen bases is called "inferior" by the botanist, but this refers to its position, rather than its quality. This is actually an evolutionary advancement over the "superior" ovary. The ovary of an orchid is especially hard to find because of an economy which is general in the orchid family. In many flowers the "ovules" or embryonic seeds are all ready for fertilization when the flower opens, but in most orchid ovaries the ovules are not present when the flower opens and they do not develop unless pollination takes place. That is why there is such a long time between pollination and actual fertilization in many orchids.

The ovary, style and stigma of the orchid are basically made up of three parts or "carpels," but these structures are so modified and grown together that they are scarcely recognizable. When the capsule opens it does not split between the carpels, but each carpel splits down the middle. If you want to see recognizable carpels, you should study the fruit of larkspur, columbine or peony.

The lip of the orchid flower is on the upper side of the bud but the ovary and the stem or pedicel, beneath it, usually twist so that the lip is lowermost in the open flower. Thus, the orchid flower is usually upside-down as compared to other flowers, and this is so general that the species which have their flowers right-side-up appear upside-down to us, which is a bit confusing. This process of twisting in the bud is technically known as "resupination."

*When we speak of parts being "grown together" we do not mean that they develop as separate parts and then grow together. Rather they grow as a single structure from the first blob of tissue which starts the flower.

Sepals and Petals

The two sets of petal-like parts in the lily flower are so similar that the botanist does not speak of them as sepals and petals, but uses the collective term perianth. It is customary, though, to speak of sepals and petals in the orchid flower, even though the outer segments are not green, as true sepals usually are. The two sets are usually rather different in the orchids, so there is some justification for this distinction. The outer set are simply called sepals, and the inner set, or two of them, petals. The inner segment which is opposite the fertile stamens is called the lip, and is usually quite different in shape, and sometimes in color, from the other five segments. It is usually the lip which gives character to the orchid flower, but there is great variation in the size and arrangement of the sepals and petals. Either two or all three sepals may be grown together, and the lip, the petals, or even the lateral sepals may be grown to the column. The number of variations which occur on the basic pattern of 3 sepals, 2 petals and a lip is truly remarkable.

That one of the petals forms the lip and that the stamens are all on one side of the flower, points to the basic difference between the orchid and the iris. The iris has three stamens, as a few orchids do, but they are symmetrically arranged, being one of the two sets found in the lily flower. The orchid is bilaterally symmetrical. It can be cut down the middle into two halves which are mirror images, but (like ourselves) it can be cut into equal and similar halves only along that one line. The iris or lily can be cut into equal halves along several different lines, since they have a basically radial symmetry.

Nectaries

Any structure which produces a sugary solution, or nectar, is classed as a nectary, and there are several types of nectary in the orchids. Many orchids have small nectaries on the outside of the sepals, which secrete nectar while the bud is developing. This activity may in some way be associated with the high rate of growth of the flower buds. Shallow, cup-like nectaries within the flower are known in many species, especially those that have a "column foot" (described below). The most conspicuous sort of nectary is the long tubular "spur," such as we find in *Angraecum*, *Calanthe* or *Habenaria*. *Cattleya* and several related genera have long tubular nectaries embedded in the base of the flower, alongside of the ovary. These are most striking in *Brassavola*, where they may be as long as six or seven inches.

Column

The column is one of the best known characteristics of the orchid family. Where most other plants have separate stamens and style in the center of the flower, these structures are united into a single organ in most orchids. In most of the better known orchids the stamens and style are grown together for their full length, but they are only partly united in *Cypripedium*, *Spiranthes*, *Neuwiedia*, and some other genera. At one time it was thought that the column was a stem structure,

Figure 2. Diagram showing how the three fertile anthers of the primitive orchids (A) have been modified. In the ladyslippers and *Apostasia* (B) the lateral anthers are fertile and the median anther is sterile or absent. In most orchids the median anther is fertile and the lateral anthers are sterile (C) or absent (D).

but we now realize that the stem ends at the base of the ovary, and the column is only the style and parts of the stamens, united and thickened. Many orchids show a peculiar structure known as a column foot. This is a ventral outgrowth at the base of the column, which has the lip jointed to its tip. This is especially striking in many species of *Dendrobium* (see figure 6).

Anther

In some orchids the anther, which is the pollen-bearing part of the stamen, is very like that of the lily or amaryllis. The ordinary sort of anther is an oblong structure with four long pollen-sacs which become two before the anther splits open to release the pollen. The anther is usually attached to a long slender "filament" at or near one end. In most orchids the filament is almost completely grown to the column, so that only its tip can be recognized as such. In most of the familiar orchids the anther is a cap-like structure sitting on the tip of the column, with the pollen beneath it. In the *Habenaria* group the anther projects beyond the rest of the column, but its base is so completely grown to

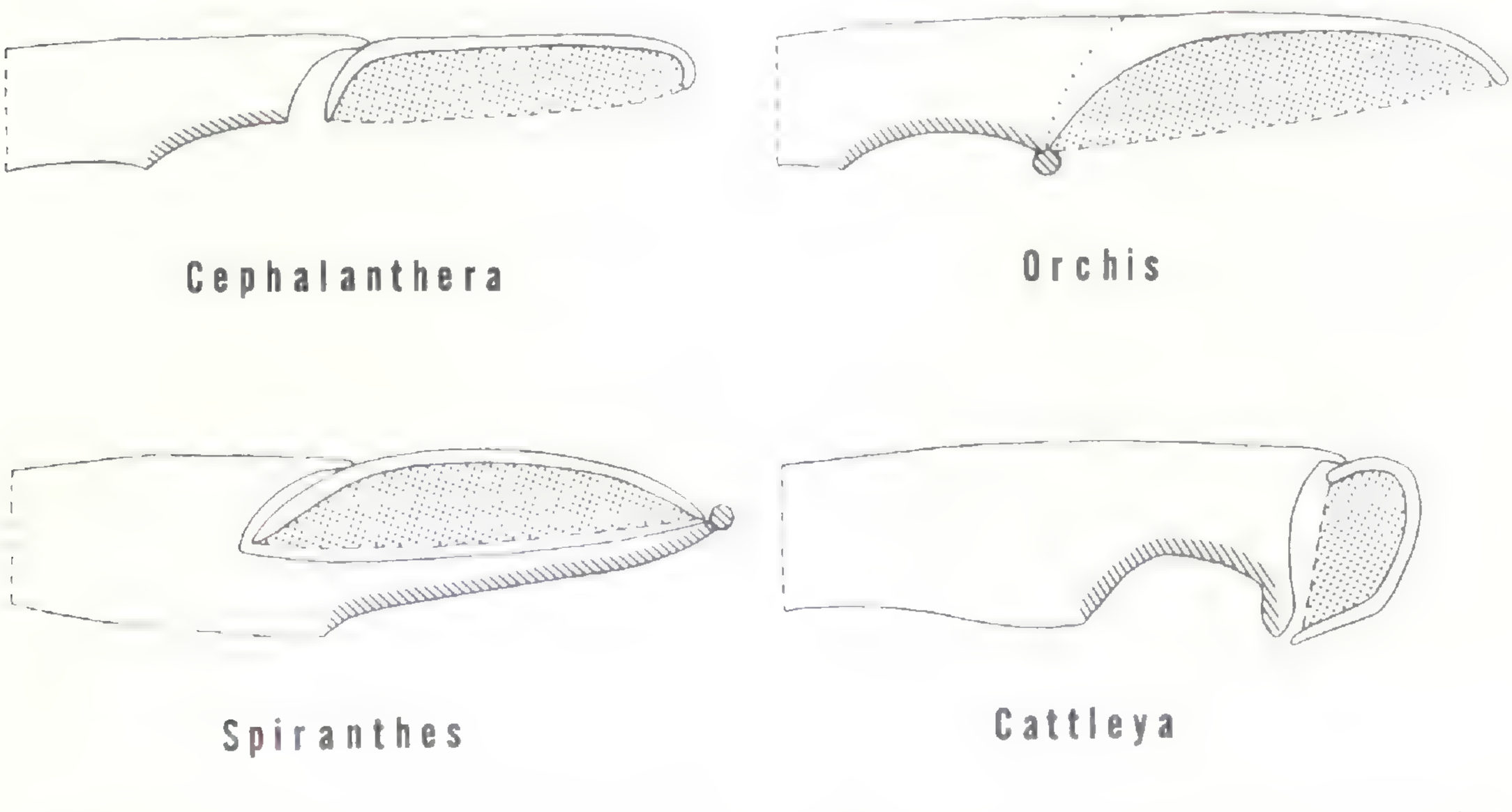

Figure 3. Diagram showing the position of the anther in different genera; the stigma is shown by hatched lines, and the pollen by stippling. In *Cephalanthera* a very unspecialized anther projects beyond the tip of the column. In *Orchis* (or in *Habenaria*) the anther projects beyond the column, but is solidly grown to the column at its base; the bases of the pollinia are attached to a viscidium (part of the stigma). In *Spiranthes* the anther is on the back of the column and the apices of the pollinia are attached to the viscidium. In *Cattleya* the anther sits on the apex of the column like a cap, and part of the stigma (the rostellum) projects downward next to the anther.

the column that one cannot tell where the column stops and the anther starts. Another peculiarity of this group is that the two halves of the anther are often widely separated, with a band of anther tissue or "connective" between them. It has sometimes been suggested that these orchids have two anthers, like the ladyslippers, but their structure and development indicate that this is not the case.

Pollinia

A few orchids have powdery pollen with separate grains, like other plants, but in most orchids the pollen grains are at least loosely bound together in masses or "pollinia." In *Spiranthes* or *Epipactis*, for example, the pollinia are two or four soft, fluffy masses which are bound together by "viscin," an elastic, somewhat viscid material derived from the tissues of the anther. There are two major types of specialization in the structure of the pollinia. In the *Goodyera* and *Habenaria* groups the pollinia are soft and mealy, as in *Spiranthes*, but each pollinium is divided into many small packets, which are attached to a viscin core by strands of viscin. When a bee carrying *Habenaria* pollinia brushes the stigma of another flower a few of the packets stick to the stigma and the viscin strands stretch and break, leaving the packets in the stigma. Thus, a single pollinium can pollinate many flowers. The pollinia which are divided into packets in this way are termed "sectile," and the packets are termed "massulae."

In the largest of the orchid tribes, the Epidendreae, we have a complete series from the soft mealy pollinia of

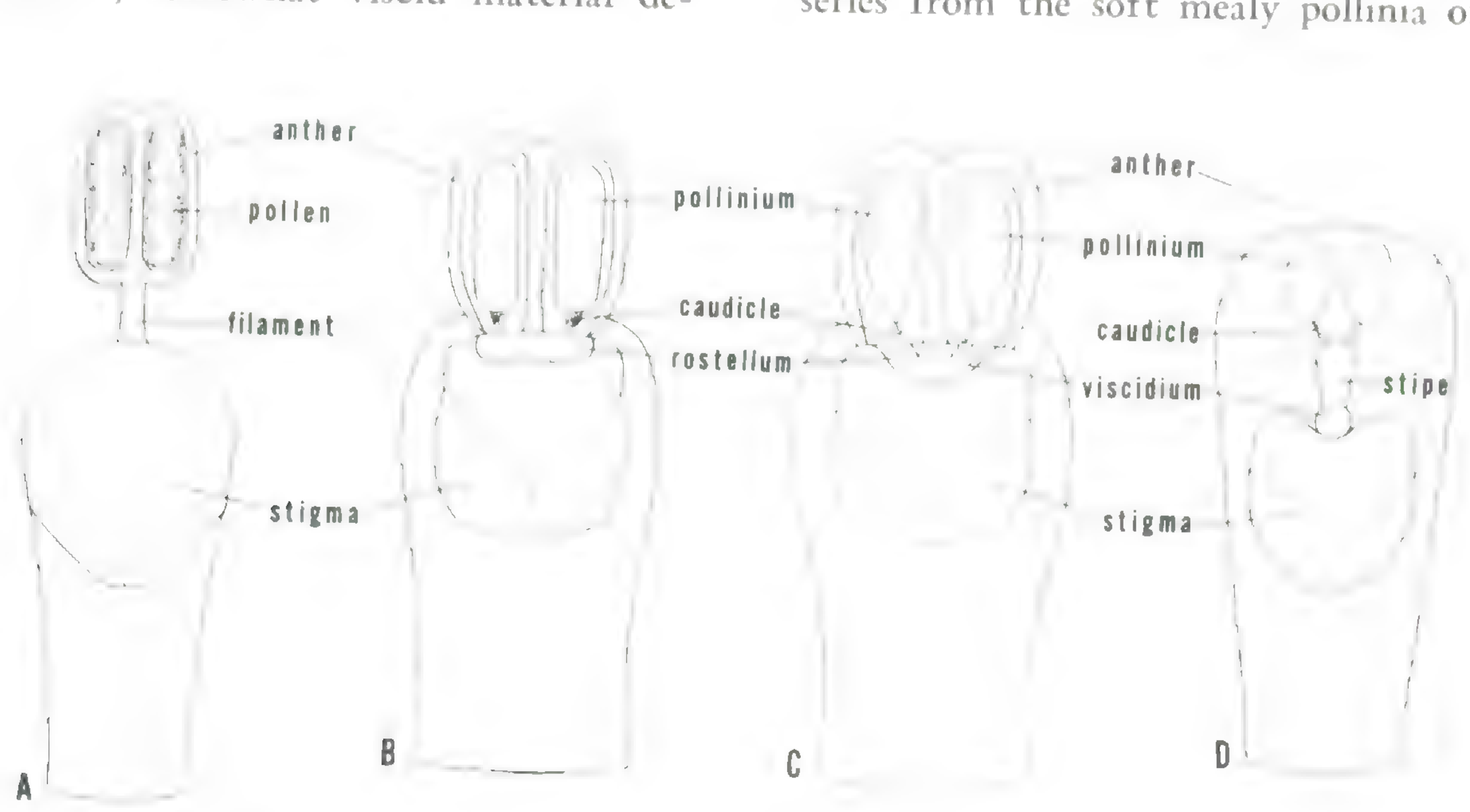

Figure 4. Diagram showing the evolution of the orchid column. The first figure (A) represents a primitive orchid similar to *Cephalanthera*, with an ordinary anther, and a simple, three-lobed stigma. B represents an orchid in which the pollinia are compact and hard except for the mealy caudicles; and part of the stigma is specialized as the rostellum. This is similar to *Cattleya*. In (C) the caudicles of the pollinia are attached to a part of the rostellum (viscidium) which is removed as a unit with the pollinia. *Cymbidium* is of this sort. (D) represents a highly evolved orchid such as *Oncidium* or *Vanda*, in which there is a strap, or "stipe," attaching the viscidium to the pollinia. In (B) and (C) the anther is shown as projecting beyond the column, to show the parts more effectively, but such orchids normally have the anther sitting on the apex of the column as shown in figure 5 (A).

Sobralia, through the more compact pollinia of *Phajus*, to the rather hard pollinia of *Cattleya* and the very hard pollinia of *Oncidium* or *Vanda*. In this group the hard "waxy" pollinia usually bear a small amount of mealy pollen with viscin strands, which serves to attach the pollinia to each other or to the viscidium (see below) and is often the part glued to the visiting insect. This mealy portion of the pollinium is termed the "caudicle." The anther of the Epidendreae may contain either 2, 4, 6, 8 or occasionally 12 pollinia.

Stigma

The three-parted nature of the pistil is reflected in the stigma, which is usually a shallow depression on the underside of the column, but is a mound-like structure in the lady-slippers. The three lobes of the stigma are quite thoroughly grown together, but are frequently separated by faint lines on the surface of the stigma. The stigma produces a sticky, sugary solution in which the pollinia become stuck. This solution is of the right concentration to stimulate the pollen grains into growth. Each pollen

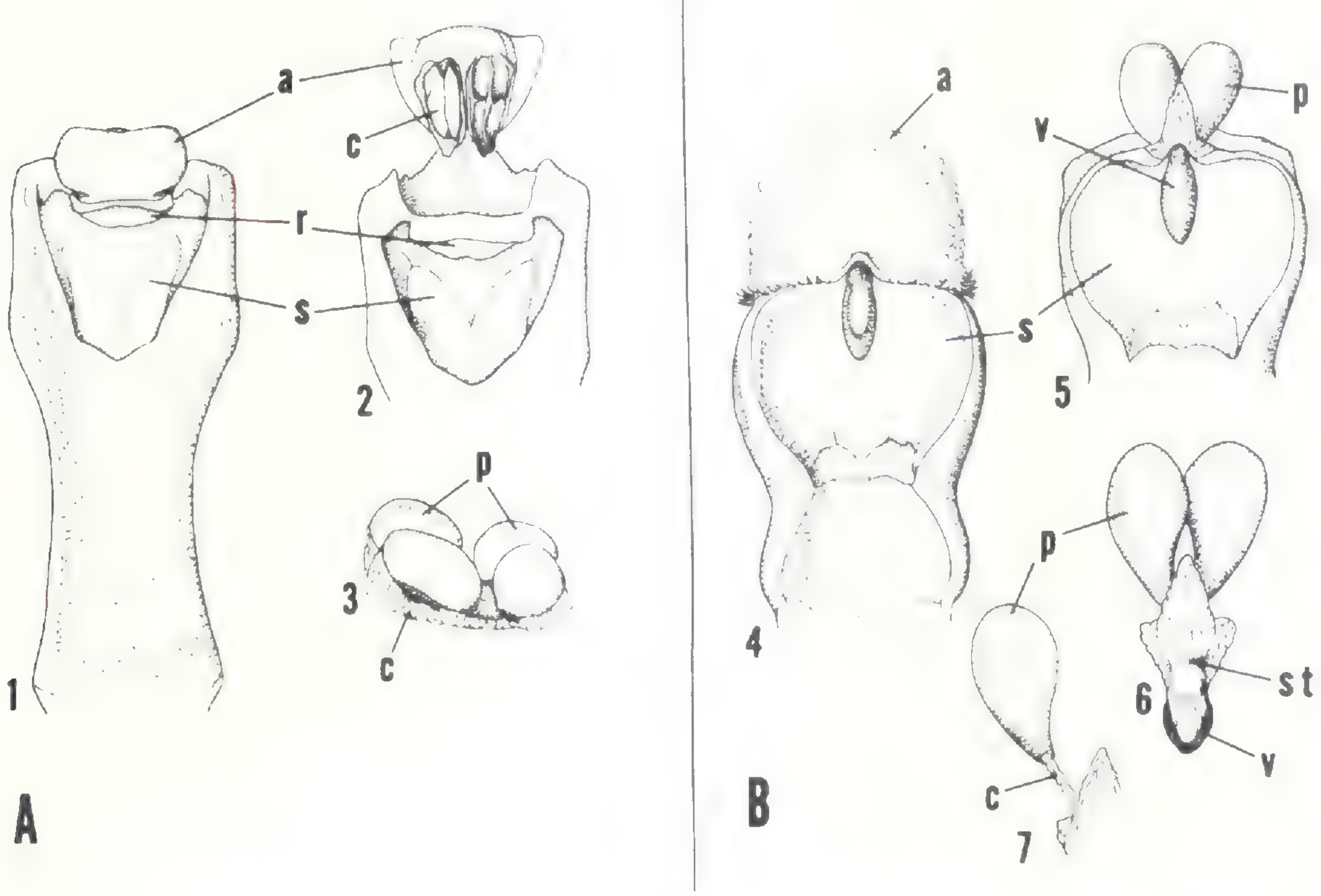

Figure 5. Column structure in two different orchids. (A) shows the column of a *Schomburgkia* (or *Laelia*), in which the structure is similar to *Cattleya*. The rostellum (r) projects below the column where a visiting insect will receive some of its glue in backing out of the flower. In the process it will tip back the anther (as in 2) and the mealy caudicles will stick to the glue-covered back of the insect. (B) is the column of a *Brassia* (similar to *Oncidium*), in which there is a well developed viscidium (v) or sticky pad which will attach to the visiting insect, and a stipe (st) or non-sticky strap attaching the pollinia to the viscidium. In 7 the pollinium (p) is pulled away from the stipe to show the caudicle (c). a, anther; c, caudicle; p, pollinia; r, rostellum; s, stigma; st, stipe; v, viscidium.

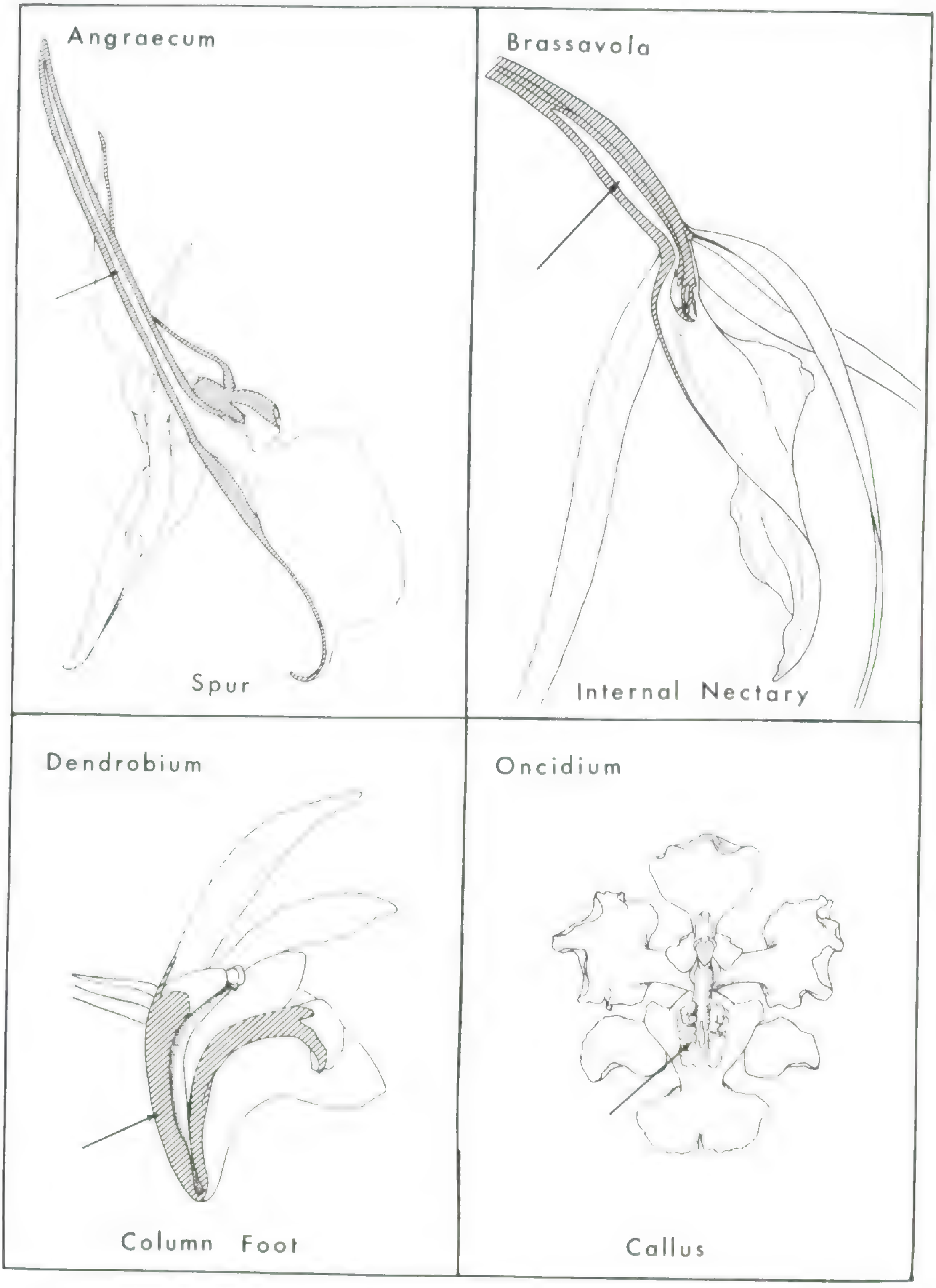

Figure 6. Some special features of orchid flowers. The section through an *Angraecum* flower shows a long spur developed from the base of the lip. In the *Brassavola* the nectary is internal and can be seen only when the flower is cut open. The base of the column in *Dendrobium* is extended into a long "foot," which has the lip hinged to its tip and has a nectary near the tip. The lip of *Oncidium* shows an ornate callus.

grain produces a slender tube which grows down the length of the column and into the ovary, where fertilization takes place. The special interest of the stigma is in that part of it which is discussed next.

Rostellum

One of the outstanding features of orchid evolution is the way a part of the stigma takes part in pollen transfer in the majority of orchids. The part of the stigma that is so specialized is called the rostellum. In the primitive genus *Cephalanthera* there is no rostellum, but insects leaving the flower usually pick up some of the stigmatic fluid on their backs and the pollinia stick to this fluid. In *Cattleya* a special part of the stigma (rostellum) sticks down in front of the anther, so that the visiting insect is almost sure to brush this part and pick up some of the glue which it produces. The flower is so designed that the insect will also tip the anther back and hit the caudicles of the pollinia with its glue-covered back or head. When it enters another flower, the pollinia stick to the stigma and the soft caudicles break. A further specialization of the rostellum is seen in *Cymbidium*, *Epidendrum* and *Sophronitis*. In these genera the caudicles of the pollinia are already attached to the rostellum before the insect arrives, and a portion of the rostellum comes off as a sticky pad, or "viscidium," with the pollinia. While this is quite a fancy structure in its own right, this is not the end of its specialization. In *Oncidium*, *Vanda*, *Stanhopea* and many other genera there is a strap of non-sticky tissue from the column which attaches the pollinia to the sticky viscidium. This band of tissue, or "stipe," is the elastic of Catasetum's cleverly contrived sling-shot, and the large pollinia of *Catasetum* show the viscidium and stipe very well. The stipe should not be confused with the caudicle, as the caudicle is a part of the pollinia, and derived from the anther, while the stipe is not. Orchids which have a well developed stipe usually have also short caudicles attaching the pollinia to the end of the stipe.

The rostellum is generally said to be one of the three stigma lobes, but this idea has sort of fallen to pieces lately because a few inquisitive botanists looked at orchids, instead of reading the authoritative works of their illustrious predecessors, and found that the rostellum is a *part* of one of the lobes of the stigma, but it is rarely or never the whole lobe.

A Glossary of Terms Describing thi Orchid Flower

I have tried to bring together here some of the commoner botanical terms, such as sepal, petal and anther, along with all of the special terms which have been used to describe the orchid flower (in English). Do not feel that you need to know nearly sixty terms to understand the orchid flower. The average grower will get along quite nicely with ovary, sepal, petal, lip, column, pollinium and stigma. The reader with more than average curiosity will likely learn anther, rostellum resupinate, nectary and spur; while a few will want to understand even callus, caudicle, viscidium and stipe. Most of the other terms are of interest only to the specialist, and even he cauld get along without many of them, with a little effort. In several cases, more than one term has been used for the same structure; in such cases we will list the preferred or best-known term in **boldface** type and the synonyms in *italics*.

Acranthous. The inflorescence terminating the vegetative shoot, as in *Cattleya* or *Epidendrum*; the term is rarely used (see also pleuranthous).

Androclinium. = clinandrium.

Antenna; pl. **antennae.** A slender appendage on each side of the column of *Catasetum*, the "trigger" which sets off the pollen throwing mechanism (*cirrhus*).

Anther. The pollen bearing structure of a flower (see also stamen).

Appendage. = caudicle.

Auricle. A small lateral outgrowth on the column of *Habenaria* and allied genera, possibly a sterile anther.

Autogamous. Self-pollinating, without the aid of insects or other visitors (see also cleistogamous).

Bract. A small leaf-like or scale-like structure at the base of the flower (below the pedicel).

Bursicle. A sack-like covering over the viscidium in some genera of the *Habenaria* group.

Callus. A crest or fleshy outgrowth of the lip, as in many species of *Oncidium*.

Carpel. A leaf-like structure which bears the ovules and seeds. In the orchids the three carpels are so modified and united that they are scarcely recognizable.

Caudicle. A portion of the pollinium which is usually slender and is composed of viscin with some pollen grains; often confused with stipe (*appendage*).

Cirrhus. = antenna.

Claw. Narrow basal portion of a lip or petal.

Cleistogamous. Refers to flowers which automatically pollinate themselves without opening; a form of autogamy.

Clinandrium. The cup-like apex of the column which partially surrounds the anther, "anther-bed" (*androclinium*).

Column. The central portion of the orchid flower, which is formed by the partial or complete union of the male and female parts (stamens and style). (*gynandrium*, *gynostegium*, *gynostemium*).

Column foot. A ventral extention of the base of the column which has the lip attached at its tip; very well developed in *Dendrobium*.

Column wing. A lateral projection from the column, as in *Oncidium*; these may sometimes represent sterile anthers.

Cuniculus. A nectary which is concealed within the ovary or pedicel, as in *Brassatola*; the term is rarely used.

Dorsal. Referring to the upper side of the flower, as the orchid flower is usually borne, as in "dorsal sepal" (see also ventral, lateral, median).

Epichile. The terminal portion of the lip in *Stanhopea* and related genera (see also hypochile, mesochile).

Filament. The slender, sterile portion of the stamen which bears the anther, forms a part of the column in the orchid flower.

Gland. = viscidium.

Gynandrium. = column.

Gynostegium. = column.

Gynostemium. = column.

Granular. Refers to pollen masses which are soft and mealy, as in *Spiranthes* or *Epipactis*.

Hypochile. The basal portion of the lip in *Stanhopea* and related genera (see also epichile, mesochile).

Incumbent. Refers to the anther which is bent downward, rather than parallel with the column (erect), as in *Cattleya*.

Isthmus. The narrow middle portion of the lip in species which have a wide gap between the lateral lobes and the mid-lobe, as in *Cattleya granulosa*.

Labellum. = lip.

Lamina. The broad flattened portion of a lip, petal or leaf.

Lateral. To either side of a vertical line drawn through the center of the flower, as in "lateral sepal."

Limb. The flat expanded portion of the lip, as opposed to the throat or claw.

Lip. One of the three petals which is usually larger and differently shaped than the other two, the median petal (*labellum*).

Massula; pl. **massulae.** A packet of pollen in those genera which have the pollinia subdivided into small packets (see also sectile).

Median. Along a vertical plane through the center of the flower and from front to back; thus the dorsal sepal may be called the median sepal; the lip, column and anther are normally median in position.

Mentum. A chin-like extension at the base of the flower; conspicuous in *Polystachya* and many species of *Dendrobium*, associated with the column foot.

Mesochile. The middle portion of the lip in *Stanhopea* and related genera (see also epichile, hypochile).

Nectary. A nectar producing structure (see also spur and cuniculus).

Operculate. Lid-like, may be applied to anthers which rest on the apex of the column like a cap (see also incumbent).

Ovary. That part of the flower which develops into the fruit; the base of the pistil.

Ovule. The structure which develops into the seed.

Pedicel. The stem which supports an individual flower, usually jointed at the base. This word has also been used to designate the stipe of the pollinia, but this is too confusing.

Peduncle. The stem which supports one or many flowers; the pedicels are attached to the peduncle.

Perianth. A collective term for sepals and petals together.

Petal. A colored, leaf-like flower part; in orchids restricted to the three inner parts, and usually to two of these (see lip).

Pistil. The female or seed-bearing element of a flower; composed of one or more carpels (3 in the orchids), and divided into ovary, style and stigma.

Pleuranthous. The inflorescence borne laterally, as in *Oncidium* or *Vanda*; the term is rarely used (see also acranthous).

Pollen. One-celled spores borne in the anther; these develop the male gametes or sperm nuclei.

Pollinarium. The complete set of pollinia with associated parts—viscidium or viscidium and stipe; the term is rarely used, but a special term is needed for the complete apparatus.

Pollinium; pl. **Pollinia.** In the orchids, a more or less compact mass of pollen; the anther may contain 2, 4, 6, 8 or 12 pollinia.

Resupinate. Having the pedicel twisted so that the part of the flower which is uppermost in bud (the lip) is on the lower side when the flower matures.

Retinaculum. = viscidium.

Rostellum. A portion of the stigma which is specialized to take part in the pollen transfer from one flower to another; the tissue which separates the anther and the functional stigma.

Sectile. The condition in which soft, granular pollinia are subdivided into small packets, which are interconnected by elastic threads; typical of *Habenaria*, *Zeuxine*, etc.

Sepal. Refers to the outermost, usually green, leaf-like elements in a flower; in the orchids refers to the three outer parts (see also petal).

Spur. A slender, tubular or sack-like projection from a flower part, usually a nectary; most commonly found at the base of the lip.

Stamen. The male or pollen-bearing element of a flower; composed of filament and anther.

Staminode. A sterile stamen or anther, as the median anther of *Cypripedium*.

Stelidium. = column wing.

Stigma. The terminal, receptive portion of the pistil; produces a viscid sugary material which receives the pollen and permits it to germinate.

Stipe. A non-viscid band or strap of columnar tissue which connects the pollinia to the viscidium, as in *Oncidium* and *Vanda*; the Latin form, *stipes*, is often used (see also pedicel).

Style. The slender portion of the pistil which connects the ovary and the stigma; forms a part of the column in the orchids.

Tetrad. A unit of four pollen grains. Pollen grains are produced in groups of four, and in many orchids they do not separate until after pollination.

Throat. The tubular portion of the lip, as in *Cattleya*.

Ventral. The lower side of the flower, as it is usually borne; the lip side of the flower (see also dorsal, lateral, median).

Viscid disk. = viscidium.

Viscidium; pl. **viscidia.** A viscid part of the rostellum which is removed with the pollinia as a unit, and serves to attach the pollinia to an insect or other object (*gland*, *retinaculum*, *viscid disk*).

Viscin. An elastic or somewhat viscid material which binds together the pollen grains in the pollinia of *Habenaria*, *Spiranthes*, etc., and in the caudicles of *Habenaria* and other genera.

Viscus. Viscid glue produced by the rostellum, especially in flowers without a viscidium; the term is rarely used.

The literature on the structure of the orchid flower is voluminous, and I will not try to give all of it here. Some of Darwin's ideas on structure have been proven wrong, but his work is still a classic. The other papers cited give more extensive bibliographies.

Darwin, C. 1862. On the Various Contrivances by which British and Foreign Orchids Are Fertilised by Insects. 365 pp., London.

Dressler, R. L. & C. H. Dodson. 1960. Classification and Phylogeny in the Orchidaceae. Annals Missouri Botanical Garden 47:25–68.

Garay, L. A. 1960. On the Origin of the Orchidaceae. Botanical Museum Leaflets, Harvard University 19:57–96.

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THE Women's Association of the Garden elected new officers of the Association on February 22nd, 1961. Mrs. J. Bruce Butler was chosen as President. (See inside of back cover for list of all officers.)

Mrs. W. Warren Kirkbride, retiring President, was presented a new Orchid hybrid named in her honor "Elisabeth Upthegrove Kirkbride." Mr. Ranlet Lincoln made the presentation with the following remarks:

"I want to tell you something about this orchid. First of all, as you can see, it is beautiful. It is distinctive among orchids by its great variety of color, and is the kind of plant that becomes more and more interesting the better you come to know it. This orchid was developed here at the Garden, and while it has a distinguished ancestry, it is in its own right an outstanding leader. Among its other qualities are that it is hardy, long-lasting, responds very well to pressure and requires no special care, nor is it fussy. It also has the most important quality of being very reliable. When you need flowers in a pinch, you can always count on this orchid to come through with a beautiful performance.

"In short, our botanists and horticulturalists have considered the matter with great care, and this orchid has been judged to be worthy of the great honor which has been done it. It has been named the Elisabeth Upthegrove Kirkbride."

Mrs. J. Bruce Butler, Mrs. W. Warren Kirkbride and Mrs. John S. Lehmann admire the new orchid.

FRIENDS OF THE GARDEN

New officers for the Friends of the Garden were elected in February, with the retirement from office of former president John A. Averill. The new President is Mrs. William R. Bascom, with Mrs. Curtis Ford and Harry E. Wuertenbaecher, Jr., continuing as Vice Presidents and Mrs. Eli M. Strassner becoming a Vice President, and Sears Lehmann continuing as Treasurer. In welcoming the new officers of the Friends, Dr. Frits W. Went expressed to Mr. Averill, for the staff and trustees, the Garden's sincere appreciation of his devoted and effective service to the Organization during the past year of transition and reorganization.

MISSOURI BOTANICAL GARDEN PROGRAMS

Special Shows and Displays

Spring Flower Show, April 2 to 30, 1961.

Daffodil Show, April 15 and 16, 1961. Sponsored by the St. Louis Daffodil Society. Out of State Judging Award of five trophies.

Free Nature Programs for children, aged seven and over, are held every Saturday morning from 10:00 to 11:30 A. M.

April 1 Sowing Seed for Your Garden
8 Flower Shapes and Names
15 Hunting for Hidden Flowers
22 Spring Safari
29 More About Your Garden Seeds

COURSES FOR ADULTS BEGINNING IN APRIL

102 Plants for Your Garden. *Basic.* 8 sessions. Fee 10.00.
Tuesdays, April 25 to June 6 (One session a field trip to be arranged). 8:00 to 9:30 P. M.
Introduction to cultivated plants for particular places and uses. How to identify and recognize them by actual study of material in the laboratory and in the field. Hugh Cutler, Instructor.

110 Home Orchid Culture. 1 session. Fee $10.00.
Saturday, April 8, 10:00 A. M. to 3:00 P. M.
Orchids suitable for home culture and best ways of growing them. Potting demonstration and practice. Students may take the plant they pot home. R. J. Gillespie, Instructor.

202 PLANT MATERIALS. *Basic.* 8 sessions. Fee $10.00.

Tuesdays, April 25 to June 6 (one session a field trip to be arranged). 8:00 to 9:30 P. M.

General instruction to enable the student to identify and recognize many forms of plant life. Students will work with living material in the laboratory. Will be combined with Course 102.

210 SURVEY OF ORCHIDS. 5 sessions. Fee $10.00.

Wednesday, April 12 to May 10. 8:00 to 9:30 P. M.

The student will learn how to identify the many unusual and common orchids using the Garden's large collections. R. L. Dressler, Instructor.

A SERIES OF FREE LECTURES ON RESEARCH AT THE GARDEN

GIVEN THE FIRST MONDAY OF EACH MONTH

ORCHID HUNTING IN SOUTH AMERICA

Dr. C. H. Dodson, April 3, 8:00 P. M. in Museum Building.

Dr. Dodson, Taxonomist and Research Associate in the Herbarium, assisting in the preparation of the Garden's "Flora of Panama."

CUTAK REPORTS (with slides) on a plant collecting trip to Colombia.

Ladislaus Cutak, May 1, 8:00 P. M. in Museum Building.

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SOME FACTS ABOUT SHAW'S GARDEN

The Missouri Botanical (Shaw's) Garden was established in 1859 by Henry Shaw, a St. Louis businessman, to be controlled by a Board of Trustees for the public benefit. The Garden is a non-profit institution which receives no support from the city or state, depending on the income from the Shaw estate supplemented by contributions from the public.

The old stone walls and cast-iron fences, the Linnean House, the Museum Building, the part of the Administration Building which was Shaw's Town House, relocated in the Garden in 1890, and the Tower Grove House, his country home, all date from Mr. Shaw's time. The Main Gate, display and growing greenhouses and most other facilities date from the period immediately following the turn of the century. The Climatron, opened in 1960, is the first of several new buildings planned for the Garden's redevelopment. It is the world's first geodesic dome, fully climate-controlled greenhouse and contains the Garden's tropical collections.

The Garden—70 acres—is open every day of the year (except Christmas and New Year) from 9 A. M. until sundown, the greenhouses 9 A. M. to 5 P. M., the Climatron Monday through Thursday 9 A. M. to 5 P. M., Friday through Sunday 9 A. M. to 9 P. M. Tower Grove House is open daily from 1 P. M. to 4 P. M. (December to March on weekends only). The Display House presents four seasonal displays: November, Chrysanthemums; December, Poinsettias; February, Orchids; Spring, Lilies and other flowers. During the year are other shows, competitions and festivals sponsored by various Garden Clubs and Flower Societies.

Courses in Botany and Horticulture for adults are conducted by the Garden staff. Children's nature studies are provided each Saturday of the year and a special nature program is held during the summer. Information on these activities is published in the BULLETIN or may be had by mail or phone. The Garden maintains a research program through the Henry Shaw School of Botany, Washington University.

In 1926 an Arboretum — 1600 acres — was established at Gray Summit, Missouri. Foot trails and roads pass through the Arboretum and are open to visitors in April and May.

The Garden Administration Building is located at 2315 Tower Grove Ave., and the Garden main entrance is at Tower Grove and Flora Place. The entrance at Tower Grove and Cleveland Avenue is also open to the public. The Garden is served by both the Sarah (No. 42) and the Park-Southampton (No. 80) city bus lines.

Persons interested in helping to support the Garden and taking part in Garden activities are urged to do so through the "Friends of the Garden". Information may be obtained from the Main Gate or by mail or phone.

COME THROUGH the GARDEN GATE!

MISSOURI BOTANICAL GARDEN

Bulletin

May 1961
Volume XLIX
Number

COME THROUGH THE GARDEN GATE
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Free Advice from Shaw's Garden Experts

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Thursday, May 11	9:30 to 9:30
Friday, May 12	9:30 to 9:30
Saturday, May 13	9:30 to 5:30

Sponsored by the Women's Association of Shaw's Garden

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Through the Garden Gate

Missouri Botanical Garden Programs

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Missouri Botanical Garden
Bulletin

Vol. XLIX No. 5 May 1961

WEEDS

F. W. WENT

If you want a lively argument, start talking about weeds. No two persons will agree on which plants are weeds. The best one can do is to define them in a negative sense: plants which are not wanted. Therefore a larkspur or a poppy are weeds in a vegetable garden, whereas turnips overlooked in harvesting are weeds in any place except in a turnip patch. Still, these are not the plants we think of when we hear the word *weed*. Names like pigweed, sow thistle, pimpernel, purslane, plantain, mallow, Bermuda grass and other grasses come to mind. Wherever the climate is favorable for their growth, they have become backaches for farmers and gardeners.

Weeds are very much as sparrows or rats among the plants. Everywhere in the world where man has arrived, sparrows and rats have accompanied him, ready to partake of the best intended for other animals or for man himself. Weeds also seem to have the exasperating almost infallible habit of finding the best prepared and richest portions of a garden. This becomes all the more maddening since generally these weeds are not found outside the garden or the cultivated field. Many of our weeds are natives from other parts of the world, especially from Europe. If the climate suits them, why have they not generally spread to the wild here?

Two of the main reasons are, that they need a rich soil for growth, and that they only sprout where soil has been recently turned. Their seeds do not germinate where they have to compete with existing vegetation. This is especially true for the wild tobacco: when sown between other plants not a single seedling will come up, but where the soil is frequently turned over, such as on shoulders of roads, it germinates freely. Wild tobacco does not require rich soil, and since it is big and easily removed it is no pest in the garden.

We really should distinguish between garden weeds and weeds in field crops. Let us first talk a moment about the latter. They usually are brought into the field by the farmer himself with his seed supply. Many of the weeds of, for instance, wheat fields, have seeds of about the same size as wheat kernels. That is why they are hard to separate from the wheat. They are harvested with the wheat because those weeds grow at the same rate, reach the same length, mature at the same time and release their seeds only after thrashing. It is very likely that as man developed wheat from a wild ancestor, by selection of the highest-

yielding strains, he unconsciously selected the weeds also: when he obtained a taller variety, all weeds not growing so tall were eliminated, but those growing as high as the wheat remained a weed. That this actually must have happened can be concluded from a remarkable observation from Russia. In hand-harvested flax fields a weed with small seeds occurred, which was eliminated through the screens of the newly introduced mechanical harvester. Within a few years a new variety of this weed had developed with larger seeds, which did not pass the screen of the harvester. In this way this plant survived as a weed.

There exists only one field crop, to my knowledge, which is naturally weed-free at harvest time. This is rice. It is weed-free because of the remarkable method of cultivation, developed in the dim twilight of civilization by natives of the Far East. Rice is one of the few land plants which tolerate growing with their roots in completely water-logged soil. During the first few months rice is grown in inundated fields. There only water plants can grow as weeds between the rice plants. When the water is drained off the field about one month before harvest, these water weeds die, and ordinarily land weeds have no chance to germinate, grow and mature in time to be harvested with the rice.

Cultivating and hoeing is, in many field crops, the method used to remove weeds. I heard an advocate of frequent soil cultivation bless the weeds, which forced the farmer to stir his soil a few times yearly, since "stirring the soil is the foundation of good farming." This can be overdone, of course, but only few people go so far as to call cultivation the "Plowman's folly."

Now we will return to the vegetable garden weeds. Why should we get rid of them? Why not give them the benefit of the saying "live and let live"? In the first place they parasitize on the nutrients put in the soil for those plants which are wanted. Whatever nutrients weeds absorb are not available for our crops. In the second place weeds are usually strong plants, which can crowd out or overshadow the vegetables and thus diminish the harvest. In the third place their presence by itself may have a harmful effect on the crop. It is alleged, for instance, that Bermuda grass inhibits growth of Citrus trees, while other weeds do not have such harmful effect. In the fourth place, where water is precious, weeds should be eliminated, since they squander water. In the fifth place, which is perhaps the most important, many weeds harbor pests, which from there can invade your garden plants and vegetables, sometimes carrying diseases which can be transmitted to crops. As examples, some virus diseases and blight of tomatoes and potatoes can be mentioned. They occur on weeds like nightshade, and can spread from those weeds to healthy tomatoes; the club root disease of cabbage, cauliflower and turnip thrives equally well on wild mustard and related weeds. Therefore, this disease may survive in weeds, while the parasite would have died from starvation if

those weeds had not played host to them. For these reasons weeds have to be controlled.

Generally speaking, chemical control of weeds in gardens is only possible where a poison can be applied which will not harm other plants or animals. But if a substance is poisonous for one creature, it usually is toxic for others too. Therefore chemical weed control is mainly practiced to keep lawns, paths, roads, tennis courts, etc., free from weeds. The simplest method except for lawns is to apply large quantities of ordinary salt. This has the disadvantage that eventually it is washed out by rain and becomes ineffective. Sodium chlorate is often used: much smaller quantities suffice, and it does a more thorough job, but its effects are also not permanent. Permanent poisons like arsenic compounds are too dangerous for general use. The sodium chlorate has been used for weed control in pasture lands; by carefully adjusting the dosage it was possible to keep down certain weeds, while the grasses were not harmed. But for your vegetable garden such chemicals are not suitable. Therefore, if you have weeds, hoe or pull them out. But you can do a lot to keep the weeds down by following these suggestions:

1. Keep your garden clean, so that no new weed seeds are produced. Weed seeds, however, remain alive for years in your soil, so that many years after you have started a campaign against weeds they continue to come up. But eventually those hang-overs from a period of less gardening activity will disappear.

2. Sow weed-free seed. Seed from reputable seed houses is carefully cleaned and can be used with safety.

3. Use weed-free manure. Fresh manure is the worst enemy of a clean garden: it is chock-full of weed seeds. When this manure has been properly composted or fermented by mixing it with leaves, straw and other plant remains, it will have heated sufficiently to destroy all seeds.

4. Let soil be fallow for a short time, keeping the surface wet. Many seeds in the surface layers will germinate and the young seedlings are easily removed by shallow discing or hoeing. For as soon as a seed has germinated, it loses all its resistance against drought, heat or wounding.

5. In addition to its other advantages, transplanting of young plants from seed beds to the field decreases the weed problem: often the transplanted plants have a sufficient head-start over the weeds, which have to start right at the beginning, so that they are not so much bothered by the weeds.

6. Use an excess of seeds when sowing, and later thin the young plants. As mentioned in the beginning, weeds only thrive where there is no competition with other plants during their germination. Carrots sown thickly will be much freer from weeds than carrots sown thinly. In the latter case they may even be crowded out by weeds before you have time to attend to them.

Sometimes weeds are grown on purpose, and then they are called cover crops. They are used here especially in winter in orchards. Then they are

turned under in the spring. By sowing a cover crop a farmer can insure the growth of beneficial weeds, whereas the cover crop itself prevents the growth of other weeds. By using leguminous plants as cover crop the soil can be enriched in nitrogen.

In the tropics many tree-crops are grown together with cover crops. They prevent excessive erosion, keep harmful weeds out, make frequent cultivation unnecessary, form a good permanent mulch and thus keep the soil porous.

Whether one thinks that weeds are a blessing in disguise, or a mere nuisance; whether they are tolerated or persistently removed, one thing is certain: weeds are most interesting from a botanical standpoint and they deserve much more research. As an illustration of this I want to mention research carried out in Java. There it was tried to determine, with the aid of soil analysis, which varieties of sugar cane could be expected to do best in certain fields. This turned out to be very difficult. But the weeds growing in such fields gave an excellent clue for the suitability of those fields for specific cane varieties. This is not surprising: after all weeds require the same nutrients as other plants, and they are very sensitive to good soil, so that they can be used as indicators of good soils. Our own pigweed can be used more or less in this way. It grows almost exclusively where the soil is rich in nitrogen, so that when you have much pigweed growing in certain areas of your garden, you do not need to fertilize with nitrogen-fertilizer in those spots.

NOBILE TYPE DENDROBIUM HYBRIDS

PETER SMITHERS, D.PHIL., M.P.

THE Missouri Botanical (Shaw's) Garden is one of very few places in the world where a large quantity of these fine orchids may be seen in cultivation. The Nobile hybrids were the symbol of an age of luxury and elegance which has passed away. At the end of the last century and until the outbreak of the second world war they were extensively cultivated in the largest and most stately of the stately homes of England. They are, indeed, the orchids par excellence for lavish and exotic display. Capable of being grown into enormous specimens, they have left in orchid history numerous records of plants carrying more than a thousand flowers. Such an object was the ideal decoration for a great staircase hall, which it would fill with a subtle fragrance and a yet subtler atmosphere of wealth and good taste. There was a further advantage. In an age when men of fashion commonly wore a buttonhole flower, the individual *Dendrobium* bloom was ideal for the purpose. Correct in size at about three and a half inches, elegant in shape, the rich colours sharply set off by the large deep maroon blotch of velvety texture which adorned the lip, it exactly fitted the man of distinction of Edwardian days.

But for other purposes the Nobiles

were not commercial cutflowers. Growing on short pedicels set all along the growths, the flowers could only be offered for sale by cutting the whole pseudobulb. Although this is now being done experimentally in Germany it has hitherto been thought too weakening to the plant for adoption as a glasshouse cultural practice. So it was that with the passing of the stately homes, and of the kind of society in which men commonly adorned themselves with orchids, the Nobile type *Dendrobium* entered a period of obscurity. The second world war saw the breakup of nearly all the big private collections or orchids, and after the war those which remained were compelled to concentrate upon genera which are good market cutflowers. Only in the famous Schroder collection at Dell Park, and in literally one or two others is there still a '*Dendrobium* House.'

Yet, curiously enough, the Nobiles are ideal for the small amateur such as myself, who does not aim at paying his costs by selling flowers. They bloom in the worst weather of the year between Christmas and Easter. Unlike so many orchids, the plants as a whole are pleasing objects for house decoration: they bloom all over and carry the right amount of attractive foliage. They grow at relatively low temperatures and thus are economical in fuel. They are very free and reliable bloomers if given a cool enough autumn rest, that is to say, below 55 degrees F. If grown upright on the stage, they occupy very little space in a small greenhouse, yet they will luxuriate in baskets as may be seen at Shaw's Garden. The flowers last about three weeks, and with a little ingenuity the plants may be brought on in succession for three months.

Development of these hybrids has taken place over a period of about a century. The collection at Shaw's Garden is of particular interest in that it contains a number of plants of very early origin. Although these are far less showy than the magnificent modern hybrids, and for this reason have disappeared from cultivation elsewhere, their preservation is fortunate since it enables the evolution of the plants to be seen and studied.

After the first world war, the Garden had a considerable accession of plants from the fine collection of Mr. F. E. Dixon of Ronaele Manor, Elkina Park, Pennsylvania, and these were used for quite an extensive programme of hybridization. But apart from this there were few additions from outside, and it is to this curious isolation from the main lines of breeding in the rest of the world that the Shaw's Garden plants owe their distinctive interest today.

In England, where the original and main subsequent development took place, there were many famous breeders, of whom Sir Jeremiah Colman of Gatton Park was the most important. He had the good fortune or the wisdom to begin breeding orchids when a young man and thus in his lifetime was able to transform the Nobiles in every respect.

Dendrobium nobile, Ldl., is a very variable species, ranging from pure white to deep reddish purple and with a wide variety of habit and form.

Many varieties are recorded, often bearing the name of the famous collection in which they originated. I have succeeded in assembling forty-two such varieties of which in my opinion 'Harefield Hall' is still the best. Shaw's Garden grows a variety under the name of Dominianum, which is not of particular merit except for an apparent tendency to bloom early, but which is of particular interest as having presumably come from the collection of Mr. Dominy, an English amateur, who raised the first hybrid orchid following upon Darwin's research into pollination, in the year 1856. I believe these to be the only plants of this variety in existence.

To introduce a range of yellow and orange colours upon the basis of the robust constitution of *D. Nobile*, three species have been used: *D. heterocarpum*, Wall., *D. signatum*, Rchb., and *D. Hildebrandii*, Rolfe. The first two species have probably been developed near to their full potential. The third offers possibilities for those who seek character and elegance rather than size and roundness of flower. The best yellow hybrids now have a good clear colour and fair shape and size. Brilliant orange and apricot tones exist of which some have an excellent shape while others, lacking in shape, are exceedingly floriferous.

At a much later date *D. regium*, Prain, was introduced from the Deccan and was at once seized upon by Col-

Dendrobium nobile flowering at Gray Summit in 1953

man for breeding. For this purpose it has three valuable characteristics. First, a very beautiful white throat gives rise to a series of hybrids with this feature in place of the characteristic maroon blotch of *D. nobile* or the chestnut lip of *D. heterocarpum*. Secondly it has a brighter and clearer reddish pink colour than any *nobile* variety; the colour is stable, and has descended to some of its progeny. Finally, it blooms six weeks to two months later than *D. nobile* and thus tends to produce offspring which extend the flowering season. The potential of *D. regium* as a parent had only begun to be exploited at the outbreak of the second world war, and when the war was over it appeared to have vanished from cultivation. Efforts to find it in the Deccan have not been successful: some Kew plants, part of a legacy, are doubtfully true but may prove to be so. After extensive search and world-wide advertisement I found a specimen of what seems to be the real thing, unprized in an amateur's tiny greenhouse in Worthing, England!

The early English and modern Japanese breeders have made extensive use of a miniature species, *D. monile*, Kranzl., to produce a race of small flowered miniature hybrids with *D. nobile* and its allies. These are exceedingly attractive and elegant little plants, often inheriting the fine fragrance of the *monile* parent. They also have a habit of blooming at odd times of the year, and thus providing an agreeable surprize for the owner. I hear that Mr. Tanaka, who is at present working in this field, expects a promising crop of new crosses to flower for the first time this year.

Attempts to use other species for hybridization with *D. nobile* have not met with much success. *D. primulinum*, Ldl., has given to one hybrid, which may be seen in Shaw's Garden, its fine broad cream coloured lip, but this has not proved easily transmissible to later generations. *D. Falconeri*, Hook., produced an exceedingly elegant hybrid, Venus. I have failed to find this in cultivation, but it meets *D. nobile* in an American cross with Lady Colman, now showing bud for the first time with me, and clearly displaying *Falconeri* blood in its slender graceful growth. *D. Wardianum*, Warn., one of the finest of all the species of *Dendrobium*, and promising for breeding because somewhat variable, has proved a most difficult parent. Ronaele, of which Shaw's Garden has a large stock, is its main achievement and has been used by the Garden for subsequent breeding. The splendid *D. Wardianum album*, which comes true from seed, is an even more disappointing parent.

A promising line of breeding for these plants is the crossing of selected fine varieties of the same parentage. It was by this means that Dell Park produced its splendid range of Models, and I understand that the same process at Shaw's Garden with two selected varieties of *Thwaitesiae* has given an interesting range of yellows, including one or two of exceptional character. Quite apart from the use of new species or the further development of some older parents, there is thus a ready means of advance open to the amateur. This would, however, be

greatly facilitated if a kindly cytologist would carry out a series of chromosome counts in *Dendrobium*, using correctly described and identified material.

In the last resort, however, a *Nobile* type *Dendrobium* is a plant for the grower. With a sharply defined annual growth of one pseudobulb, it provides him with the unspeakable smug satisfaction of noting the day when the current year's growth has exceeded in fatness or length or both, that which went before.

Mr. Peter Smithers, D.Phil., of London, England, and Member of Parliament, is an amateur grower of Orchids. He has, for several years, been building a collection of the various hybrids and species of the deciduous *Dendrobiums* with a special effort to obtain and preserve many of the almost extinct hybrids of *D. nobile*. He recently spent several days inspecting the deciduous *Dendrobium* collection here at the Garden and considered it to be one of the finest in the world.

CLIMATRON RECEIVES HIGHEST INTERNATIONAL AWARD FOR ARCHITECTURAL EXCELLENCE

SELECTION of the Climatron as the first American recipient of the $25,000 R. S. Reynolds Award, the largest international award for architectural excellence, was announced April 2 by the American Institute of Architects which conducts the competition.

In citing architects Joseph D. Murphy and Eugene J. Mackey and Garden Director Frits W. Went for the Climatron, a jury of distinguished architects stated, "the tropical lyricism of the botanical displays seem so successfully carried out by the architects of this structure, that it must be a marvelous experience for the visitor to enter this great space." They added, the Climatron is "sensitively executed and strikingly appropriate to its purpose." The Geodesic dome structure follows principles established about 10 years ago by R. Buckminster Fuller and is the first application of Geodesic engineering for a greenhouse.

The R. S. Reynolds Memorial Award is conferred annually by the AIA on the architect who has designed "a significant work of architecture, in the creation of which aluminum has been an important contributing factor."

Director Frits W. Went

The Climatron's Geodesic structure as well as the frame work for its Plexiglas liner are aluminum.

The award was presented formally to Messrs. Murphy, Mackey and Went April 26 at the AIA convention in Philadelphia. Previous Reynolds awards were given for buildings in Spain, Belgium, Australia and Switzerland.

BOOK REVIEW

Trees, Shrubs and Woody Vines of the Southwest, by Robert A. Vines. Illustrated by Sarah Kahlden Arendale, published by University of Texas Press.

This book is well worth its rather high price of $25.00 per copy. It will make a perfect gift for any plant lover in the Southwest, but the number of Missouri trees described is so great that it will also be most useful for persons in that State.

More than 1,200 species of native and naturalized woody plants of the Southwestern United States are described. In addition to its general description, each plant is beautifully illustrated by Miss Arendale. Her drawings have been very much reduced in reproduction, and in a few cases, for instance *Haplopappus laricifolius* and *Viburnum rafinesquianum*, have lost in the reproduction. However, in the great majority, these drawings are quite magnificent. They are done with a special technique which brings out the rounded contours of the leaves. With a stippling technique the hairy plants look very hairy. Many of the plants have been drawn from nature, as can be seen, for instance, in the case of the White Fir, which apparently grew at a low altitude and which has abnormal leaves, when compared with a tree growing in its natural surroundings.

These illustrations substitute largely for the lack of keys. It is possible to look through the pictures and thus identify a tree. With the detailed description, it will be possible to positively identify practically every tree in the Southwest.

Also quite valuable are the most informative remarks which can be found with each species. These remarks are concerned with details about the growing of the plant, economic uses, remedies against it (such as poison oak, poison ivy), etc. I have seldom seen so complete a book.

There are certain mistakes, such as, for instance, the altitudinal range of the Engelmann spruce, which is given as from 5,000 to 15,000 feet. Actually, the highest trees do not grow above 12,000 feet. But such mistakes are unimportant. Plant lovers will enjoy this book.

Review by F. W. Went, Director, Missouri Botanical Garden, St. Louis, Missouri.

FRIENDS OF THE GARDEN

FRIENDS of the Garden are working vigorously these days with the aid of more than 100 members who have volunteered to help increase the organization's membership substantially during 1961.

With their contributions to the Garden up 60 per cent in 1960 over 1959, Friends, under the leadership of Harry Wuertenbaecher, Jr., vice-president for membership, are committed to the goal of continuing to enlarge Garden support as much as possible.

An Executive Council was recently appointed by Friends' president, Mrs. William R. Bascom, to promote activities in several directions. Mrs. Curtis Ford, vice-president, and Mrs. James L. Sprunt are council co-chairmen for a new volunteer program now being developed. Mrs. Samuel Libermann and Mrs. Robert M. Smith are chairmen, respectively, of activities and illustrations committees. Other members of the new Council are:

Mrs. John R. Averill, Mrs. J. Bruce Butler, Mrs. Dozier L. Gardner, Mrs. John Raeburn Green, II, Mrs. William J. Hedley, Mrs. Merl C. Kelce, Mrs. Sears Lehmann, Jr., Mrs. Fristoe Mullins, Mrs. Gilbert J. Samuelson, Mrs. Edward F. Schweich and Mrs. James A. Seddon.

"We plan to do more for our mem-

Friends of the Garden officers for 1961 are shown during a recent visit to the Climatron: Mrs. William R. Bascom, president; Mr. Harry Wuertenbaecher, vice president membership; and Mrs. Eli M. Strassner and Mrs. Curtis Ford, vice-presidents.

bers—and do ask our members to do more for the Garden," Mrs. Bascom said. Following an intensive membership effort, a kind of "celebration garden party" is tentatively being planned for the fall to be one of the outstanding Garden events of the year.

Mrs. Kay Miller has joined the Garden staff as executive secretary for the Friends.

THROUGH THE GARDEN GATE

THE second annual Garden Gate exhibition and sale will be held May 11 through 13 by the Women's Association of Shaw's Garden in cooperation with Famous-Barr at the firm's Clayton parking lot.

Last year's Garden Gate event was so successful that many supplies were sold out the first day, so members of the Garden Clubs, Herb Society, Women's Association and other volunteers have been busily at work, some of them since last fall, developing plant materials and other supplies for this year's event.

Under the direction of Mrs. J. Bruce Butler, Women's Association president and Garden Gate co-chairmen, Mrs. Arthur H. Fuerbacher, Jr., and Mrs. Bert A. Lynch, Jr., an elaborate selection of plants and garden equipment is being offered for sale as well as the services of an horticulturist and, at specified hours, an authority on flower arrangements.

"Too numerous to mention" are the proper terms to describe the Garden Gate's bounty, but a brief preview of the sale follows. Ground covers, including four kinds of ivy, have been

View of the 1960 Through the Garden Gate Exposition on the Parking Lot, Famous-Barr, Clayton, Missouri. PHOTO P.A.K.

prepared by Mrs. Hazel Knapp; house and terrace plants with, for example, 16 new varieties of coleus from England have been prepared by Mrs. William W. Spivy, and the Ladue Garden Club's project of more than 20,000 annuals and perennials are a sample of the plant materials available.

Mrs. Eric Newman and Mrs. Wayne Bigler have outfitted a straw market and "touch of elegance" booth with hundreds of items and a special feature "antiques for the garden," a category that was sold out within an hour last year, Mrs. Butler reports.

Visitors to the Garden Gate will also appreciate an enlarged Herb Restaurant (sidewalk variety) under the sponsorship of the St. Louis Herb Society.

Most important of all, proceeds from the three-day festival go directly to the benefit of the Missouri Botanical (Shaw's) Garden.

MISSOURI BOTANICAL GARDEN PROGRAMS

Special Shows and Displays

African Violet Show, May 6 and 7
Aquarium Society Show, May 13 and 14
St. Louis Horticultural Society Spring Flower Show, May 20 and 21
Rose Show, May 27 and 28

Free Nature Programs at Museum Building for children, aged seven and over, are held every Saturday morning from 10:00 to 11:30 A. M.

May 6 Plants from Historic Times
May 13 Planting Your Garden
May 20 Color Sound Movies
May 27 Shades of the Night

Courses for Adults Beginning in May

204 Field Botany, Spring, 3 sessions, fee $6.00

Saturdays, May 20 and 27, June 3. Start from the Garden, 10:00 A. M. Experimental Greenhouse. Field courses are designed to enable the student to recognize common wild flowers and weeds in the Spring and to understand plants' relationships with their environment. Instructors Dr. E. Anderson, Dr. R. L. Dressler and Mr. Louis Brenner.

A Series of Free Lectures on Research at the Garden

Given the First Monday of each Month, 8:00 P. M. in the Museum Building.

Cutak Reports (with slides) on a plant collecting trip to Colombia, South America. Mr. Ladislaus Cutak, May 1.

Aroids of Tropical America, Dr. George S. Bunting, June 5.

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MISSOURI BOTANICAL GARDEN

Bulletin

JUNE, 1961
Volume XLIX
Number 6

COVER: Waterfall in the Climatron

PHOTO BY JACK ZEHRT

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A Picture review of the Garden for 1961

We present a collection of photographs of the Garden some of which are older popular views, while most are from the latest best photographs taken in 1960-61.

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Vol. XLIX No. 6

Missouri Botanical Garden Bulletin

June 1961

HENRY SHAW
Founder and Benefactor

Last photograph taken four years before his death.

PHOTO BY HEDRICH AND BLESSING

The Climatron at night, from a photograph which accompanied presentation of the R. S. Reynolds Memorial Award for architectural excellence to St. Louis Architects Murphy and Mackey who developed plans for this structure in consultation with Dr. Frits W. Went.

Frits W. Went, Director of the Garden
under whose leadership the Garden has
arked on a comprehensive program of re-
ilitation, the first step of which is the
natron.

TO BY ARTHUR FILLMORE

OTO BY L. G. BRENNER

The Amazonian bog and pool in the southeast section of the Climatron which is the hottest part and corresponding to a tropical lowland jungle where a tropical forest is being developed.

trance to the underwater display tun- in the Climatron where visitors can serve the underwater structure of atic plants such as the giant water- *Victoria cruziana.*

OTO BY PIAGET STUDIO

The Waterfall in the northwest section of the Climatron where a tropical mountain or mist forest is being planted.

OTO BY L. G. BRENNER

The Linnean House named after the 18th century botanist, Linneas. This is the only greenhouse remaining from Mr. Shaw's time. It is the oldest greenhouse still in use west of the Mississippi River and now houses the Garden's Camellia collection.

PHOTO BY E L EVINGER

The Linnean Garden which contains perennials with a few choice shrubs and some bulbous plants. The large shrub in this photograph is the "Sweet Bay", *Magnolia virginiana.*

PHOTO BY P A KOHL

One of the old lily pools, with the main gate in the backgound, taken at night for the Centennial celebration, October 1959.

PHOTO BY PETER FERMAN

The Rose garden originally designed by Mr. John Noyes with paths which radiate from center bed of "Tiffany" and "The Fairy" roses. A series of arch arbors at each radial approach provides a support for popular climbing roses.

PHOTO BY P A KOHL

PHOTO BY L CUTAK

Tropical Water-lilies of the genus Nymphaea

Mrs. George H. Pring, a day bloomer.

e leaves of the giant water-lily (Victoria cruziana) will sup-
rt as much as 100 pounds if the weight is evenly distributed
illustrated by this photograph.

OTO COURTESY POST DISPATCH

PHOTO BY JACK ZEHR

Tower Grove House, the country home of Mr. Henry Shaw. This house built in 1849 and rehabilitated in 1954, is now open to the public daily 1:00 PM to 4:00 PM with hostesses from the Missouri Federation of Women's Clubs. A winter's night scene.

A. View in the northwest parlor. Old candle chandelier is from Mr. Shaw's Town House dining room.

B. The south bay used by Mr. Shaw primarily as an office. The studded box in lower right corner is a strong box which served as a safe for his payroll.

C. The dining room furnished with Mr. Shaw's Town House furniture.

PHOTO BY SHAW CAMERA SHOP

A.

B.

C.

PHOTO BY E. L. EVINGER

South front of the Old Museum and Library built by Mr. Shaw in 1849.

Interior of main salon showing balcony and frescoed ceiling. Now used as a garden lecture room and as a meeting hall for various garden clubs.

OLD GARDEN PHO

PHOTO BY E L. EVINGER

View south from the knolls showing north front of the Old Museum and the statue of Victory. This statue is housed in the original mausoleum build by Mr. Shaw. He later build a larger and "more permanent" mausoleum of red Missouri granite within the grove of trees from which the estate derives the name Tower Grove.

OTO BY E. L. EVINGER

e Mausoleum of Mr. Shaw started in 85 and completed shortly after his ath in 1889. It was completely renov- d in 1960 by the Historical Commit- of the Women's Association. Mr. aw is buried beneath a sarchopagus ich he had sculptured before his death.

This was Mr. Shaw's Town House originally located on the southwest corner of Seventh and Locust Streets. The house was moved to the Garden in 1890 by request of Mr. Shaw in his will. It now serves as Administrative Offices.

PHOTO BY PAUL A KOHL

Chrysanthemum Display, November

Four of the Garden's five annual flower

Orchid Show, February

ed and executed by Paul A. Kohl.

BY PAUL A. KOHL

Flowering Bulb Show, March

Spring Flower Show, April

Butterflies and other insects for identification and study.

PHOTO BY ARTHUR FILLMOR

Educational Programs for Childre
are conducted in cooperation wit
the Pitzman Foundation during th
summer months.

Children go for a nature walk into the North American Tract which is a naturalized area of the Garden.

PHOTO BY ARTHUR FILLMORE

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COVER: The Pitzman Nature Program. Tim Gauss, a student in the first session of the program held this summer, is shown with his insect net after catching a butterfly in an open area of the Garden's North American Tract. Tim made his net in a Pitzman Class, using cheesecloth, string and a bent wire coathanger. Photo by Brian Gordon.

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Missouri Botanical Garden Programs

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Volume XLIX No. 7 September 1961

HALLUCINOGENIC FUNGI

NORTON H. NICKERSON

One of the more interesting bits of knowledge which is a part of the science of botany concerns the property of certain toadstool-like or mushroom-like fungi to induce hallucinations in the minds of human beings who consume them. Although there is only little literature on the subject, one work stands out for those who are interested but who are not mycologists (specialists in fungi); it is a book entitled "Mushrooms, Russia and History"* by Valentia P. and R. Gordon Wasson. Printed in a limited edition of 512 copies in 1957, this two-volume work is a "labor of love" written, in the words of the authors, "for connoisseurs of edible mushrooms by amateurs." It traces, among other things, the role played by mushrooms in the daily lives of the various European peoples, especially their use as foods and in the folklore of the country. Delving into many other aspects, the books cover etymologies of words such as "mushroom," "toadstool" and "mycology," suggesting at one point that the hallucinatory properties of mushrooms, known to the ancient Greeks as "mycos," may have provided the basis for our words "mystery" and "miracle," by freeing the imagination of prehistoric man. This account draws heavily on their book, both because of the personal experiences which they relate and the work to which they have gone in assembling references from many different sources.

One of their conclusions is that the mushroom, fly amanita *(Amanita muscaria)* of Europe and Asia, often considered poisonous, is instead an inebriant, and of only doubtful value in the killing of flies. The secret of these mushrooms was apparantly lost from Europe long ago, but it still lingers on as an aftermath of an ancient tabu in the words "toadstool" in English, "God's food" in Greek and "devil's bread" in Flemish.

For us in America, there is special meaning in the Wassons' studies, because their search carried them deep into the hinterlands of Mexico in the hope that they would be able to find out the truth of statements in some of the old Spanish codices (records of the early American civilizations often composed with great care by the friars who were sent among the natives from Spain's church) that there exists today a living cult of sacred mushrooms. Ten such early references attest to this use of mushrooms, but in 1915, W. E. Safford, addressing the annual meeting of the Botanical Society of America in Washington, D. C., vehemently denied their existence. He

*Pantheon Books, Inc., New York.

insisted that what had really been referred to were dried cactus buttons (peyote). His attitude provoked an immediate search by people who felt that the early writers would most definitely tell dried cactus buttons from mushrooms, and in 1936, Robert J. Weitlaner rediscovered these curious mushrooms. His specimens belonged to the genus *Panaeolus campanulatus* var. *sphinctrinus*. The first modern-

P.A.D.

Jean-Henri Fabre, *Panaeolus campanulatus* Fr. ex L.

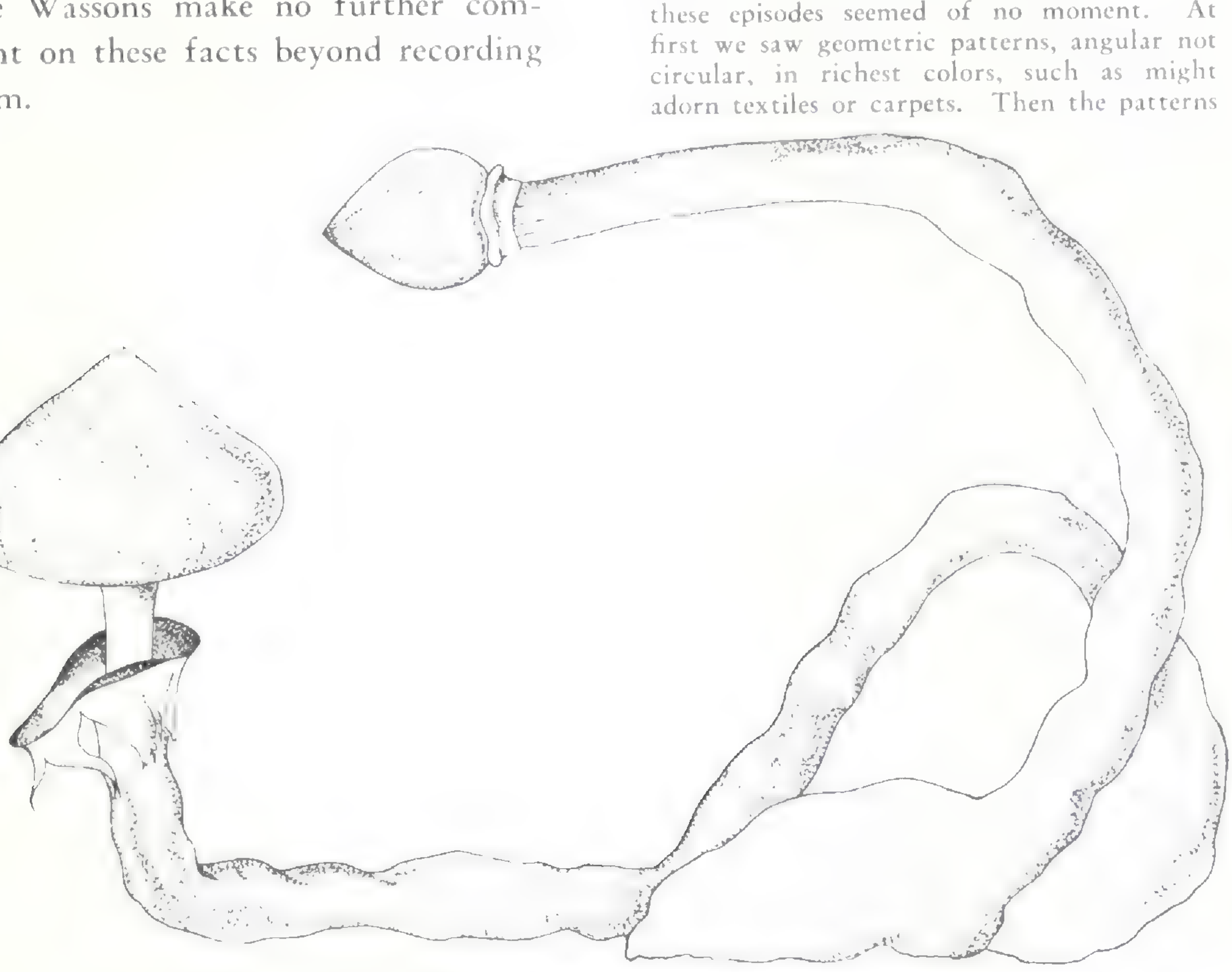
known mushroom rites were attended by 4 white persons in 1938, but were only sparsely written up as regards the divine mushrooms. The Wassons wondered whether there were other divinatory mushrooms, possibly of different genera and species. Correspondence with one Miss Eunice Pike provided them with much valuable insight on how the native Mazatec Indians regard the (for them) sacred mushrooms. The Wassons' reaction to her letter was to journey themselves to the town of Huautla in the state of Oaxaca, where they hoped to witness the rites, collect the fungus involved and possibly try consuming the mushrooms themselves. Their journey was like many taken to remote corners, where one after another the more modern modes of transportation give way to those far more primitive. After their arrival, in August 1953, a week followed during which they were brought several kinds of divine mushrooms and were told by various villagers of the folklore connected with their use.

Just before the day of scheduled departure, and when they had about given up hope of ever having any chance to learn anything further, they discovered that their guide was a *curandero*, or "wise man," who often conducted the very ceremonies they wanted so much to witness. He agreed to help them that night. They made careful notes of all ceremonial items, including cacao beans, hen's eggs, brilliant feathers, maize kernels, fourteen pair of sacred mushrooms and the order in which they were employed. The 14 pairs of mushrooms were consumed within one half hour by the *curandero*. The Wassons had asked for knowledge of their son, whom they believed to be in Boston at that time. Don Aurelio, the *curandero*, informed them that their son was in New York, not Boston; that he would be sent to war possibly to Germany; that he was in mental turmoil, but thinking of his

parents. Later that same evening, he told Mr. Wasson that a relative of his was destined to fall seriously ill within the year. The session, which began at 9 P. M., ended at 2:30 A. M. Next morning, the Wassons were on their way back to New York. They dismissed the *curandero's* predictions as thin examples of divinatory power, but then recorded the following. Their son had been in New York, not Boston, when they were in Mexico attending the mushroom rites. Later in the fall, the boy enlisted in the army, prompted by an emotional crisis which had been fomenting while his parents were in Mexico. He was later sent, however, to Japan and not to Germany. Within six months, one of Mr. Wasson's first cousins, in good health and in his early forties, died of heart failure. The Wassons make no further comment on these facts beyond recording them.

In 1955, they visited another Mazatec village, and were privileged to partake in another ceremony, with a *curandera* (wise woman) officiating. She offered Mr. Wasson six pair of mushrooms, which of course thrilled him, since the moment represented a dramatic culmination to his years of pursuit of the sacred mushroom cult. He records the taste as being acrid and unpleasant. About an hour after eating the mushrooms, Wasson and his companion (also from New York) began to see visions. He records his experiences, often in the third person, as follows:

> There is no better way to describe the sensation than to say that it was as though his very soul had been scooped out of his body and translated to a point floating in space, leaving behind the husk of clay, his body. Our bodies lay there while our souls soared. We both felt nauseated . . . , but these episodes seemed of no moment. At first we saw geometric patterns, angular not circular, in richest colors, such as might adorn textiles or carpets. Then the patterns



Ceremonial Mushrooms *Stropharia cubensis* Earle P.A.D.

grew into architectural structures, with colonades and architraves, patios of regal splendor, the stone-work all in brilliant colors, gold and onyx and ebony, all most harmoniously and ingeniously contrived, in richest magnificence extending beyond the reach of sight, in vistas measureless to man. For some reason these architectural visions seemed oriental, though at every stage RGW pointed out to himself that they could not be identified with any specific oriental country. They were neither Japanese nor Chinese nor Indian nor Moslem. They seemed to belong rather to the imaginary architecture described by the visionaries of the Bible. In the æsthetics of this discovered world Attic simplicity had no place: everything was resplendently rich.

At one point in the faint moonlight the bouquet on the table assumed the dimensions and shape of an imperial conveyance, a triumphal car, drawn by living creatures known only to mythology. With our eyes wide open, the visions came in endless succession, each growing out of the preceding one. We had the sensation that the walls of our humble house had vanished, that our untrammeled souls were floating in the universe, stroked by divine breezes, possessed of a divine mobility that would transport us anywhere on the wings of a thought.

A few nights later, again taking mushrooms in the same room, Mr. Wasson reported that his visions were different. To quote again:

> There were no geometrical patterns, no edifices of oriental splendor. The patterns were replaced by artistic motifs of the Elizabethan and Jacobean periods in England—armor worn for fashionable display, family escutcheons, the carvings of choir stalls and cathedral chairs. No patina of age hung on them. They were all fresh from God's work-shop, pristine in their finish. The beholder could only sigh after the skill that would have fixed those beauteous shapes on paper or in metal or wood, that they might not be lost in a vision. They too grew one out of the other, the new one emerging from the center of its predecessor. Here as in the first night the visions seemed freighted with significance. They seemed the very archetypes of beautiful form and color. We felt ourselves in the presence of the Ideals that Plato had talked about. In saying this let not the reader think that we are indulging in rhetoric, straining to command his attention by an extravagant figure of speech. For the world our visions were and must remain "hallucinations." But for us they were not false or shadowy suggestions of real things, figments of an unhinged imagination. What we were seeing was, we knew, the only reality, of which the counterparts of every day mere imperfect adumbrations. At the time we ourselves were alive to the novelty of this our discovery, and astonished by it. Whatever their provenience, the blunt and startling fact is that our visions were sensed more clearly, were superior in all their attributes, were more authoritative, for us who were experiencing them, than what passes for mundane reality.

And what of the aftereffects? Mr. Wasson reports that on both occasions he fell asleep about 4 A. M. and awoke about 6 A. M. with a completely clear head and full memory of all that was said or that he had imagined during the previous night. Apparently the mushrooms are not habit forming, nor does use of them affect one's threshold of tolerance. There is a consistent but often different number of mushrooms needed by different people to obtain the same effect.

This short account is again evidence that archaic peoples often possess knowledge of plants for which we, in our preoccupation of doing things "our" modern and scientific way, have seldom given them credit. Fortunately, the search for new drugs in the juices of time-honored plants of primitive societies ranging from the *curare* poisons of South America to the reserpine-bearing *Rauwolfia* of India, is well under way. The Nahuatl (Aztec) word for these divine mushrooms is *teonanácatl*, translated "God's flesh." There may yet be more truth than poetry in this ancient name. We may expect news in the near future of drugs isolated from hallucinogenic and possibly other fungi which may prove useful in treating psychotic disorders of all sorts.

THE TREE OF HEAVEN, *AILANTHUS ALTISSIMA*

I. A Blessing and a Curse

EDGAR ANDERSON

It was 210 years ago that Father d'Incarville, a missionary priest, gathered seeds of this Chinese tree in Nanking and forwarded them to his English correspondent, Peter Collinson. In the two intervening centuries the tree has gone in and out of fashion. It has been more highly praised and more roundly damned than any other tree. Tolerant of smoke, thriving in spite of neglect, it has sown its seeds in slum areas and industrial districts from Boston to Atlanta. It is indeed "the tree that grew in Brooklyn" and before smoke control changed St. Louis gardening patterns, it became the prevailing, and in many neighborhoods the only, tree from Kingshighway to the Mississippi River.

For a time it seemed to have industrial possibilities; since its leaves are eaten by the larvæ which produce one of the tough "pongee" silks, it was the subject of extensive silk production experiments in France, Algeria, and the southern United States.

Before the nature of malaria was understood, Ailanthus was ballyhooed for intensive planting along city streets to absorb noxious vapors and thus promote the health of the citizens. When epidemics persisted in spite of mass plantings, it was then suspected of causing them. "Might not this tree which so fully absorbs poison, also throw off toxic effluvia? May it not store up the noxious gases and again let them forth in the flowering season?" Though today these ideas strike us as fantastic, now that it is widely understood that malaria is a disease due to parasites in the blood stream, spread by mosquitoes, they did not seem unlikely when it was generally thought that malaria was the result of breathing in bad air. As a generator of unpleasant odors, Ailanthus is outstanding among our foliage trees. All parts of the tree have a foul odor when crushed and during the flowering season in early summer, the male trees can be smelled at a considerable distance. So well known is this unpleasant characteristic that instead of "Tree of Heaven" the common name in certain areas is "Stinkwood" or "Stink Tree."

An even more serious objection is the amazing capacity to spread both by seed and root. The seeds occur in great shaggy masses and break away at

Branch with Fruit

PHOTO BY E.L.I

various times during the winter and spring. Each seed is set in a curving papery wing about two inches long and a quarter of an inch wide. It blows long distances in a high wind; it whirls gracefully downward in quiet air; it can skid rapidly along over the surface of the snow or along a smooth sidewalk; it also floats effectively in the merest trickle of water; it is planted far and wide and has a special capacity for getting down in between stone blocks or between a building and an adjacent pavement.

Gardeners who live within a block's distance of a fruiting tree learn to keep a sharp eye out for the distinctive seedlings. They not only spread into flower beds but they have a disturbing habit of coming up among the shrubbery where it takes a sharp eye to spot the seedlings while they are still small enough to remove readily. They grow rapidly in hot weather (frequently well over a foot the first season) and soon reach the stage where they merely break off when an attempt is made to remove them. They then come back again and again from the same root, usually gaining a little root strength with each attempt to dislodge them, until it takes a major operation to get them out of the shrubbery.

It is not until one makes a careful study of the Ailanthus trees he comes across, that he gradually realizes what a very great proportion of them in the eastern United States are self sown. Most other trees one sees in the city are obviously planted; they occur along the sidewalk in formal rows, they are set out in matched pairs in front yards, they are nicely placed with due relation to the house and the garden. These are the very places in which Ailanthus trees are seldom or never found. They are commonest along the boundary fences between one piece of property and the next; there are more of them along alleyways than along streets; they rise out of clumps of shrubbery or grow slantwise next to a building or a wall. They frequently come up between the backfence and the alley or alongside the garage or an old ashpit. The Ailanthus which did not volunteer and was obviously purposefully planted in the place where you find it, is very much the exception.

Some of the most amazing Ailanthus trees are those which have been vigorously cut back or dehorned. The new sprouts frequently grow five to ten feet a year under such treatment and

Volunteer Tree showing habit of growing near foundations. PHOTO BY F.L.J

produce weird plumes of foliage during the summer, followed by gaunt, stiff skeleton branches the following winter.

If Ailanthus trees spread only by their seeds they could be something of a nuisance; it is their ability to come back vigorously from root sprouts that can make well-established trees a real problem when it comes to removing them. If an old tree is cut down it can sprout back vigorously from the root, not only right next to the stump but even a hundred feet or more away. If conditions are just right, up come dozens of young trees scattered over a considerable area. Unless vigorous and intelligent steps are taken, one will have an Ailanthus thicket for many years to come. It is best to wait until the sprouts are well-developed and then spray them with a brush-killing herbicide. The induced abnormal growth will cause the sprouts to die back but usually this is not enough to eliminate the roots completely. The treatment may have to be repeated for a second or even a third time.

The problem with Ailanthus therefore is that the tree has the capacity for becoming a real weed, spreading into areas where it is not wanted and from which it can be dislodged only with persistent effort. It has the further disadvantage of being brittle, thus breaking easily in a wind storm.

On the positive side, it is a handsome tree which will endure smoke and neglect. Hundreds of thousands of city dwellers, particularly those in downtown areas, would have no shade for their homes if it were not for Ailanthus. The red-fruited variety (rarely seen in the eastern United States) is spectacularly beautiful over a period of months each year. City parks are much more attractive where Ailanthus has been wisely used. It has been established around the rocky areas in Central Park very effectively and in the St. Louis zoo it is the principal tree around animal houses and in the animal yards. For all its faults, it has certain rare advantages. It may be a curse at times, but it can also be a blessing.

THE SCENT OF THE UPLAND BONESET

In the late summer the gray-white flowers of the upland boneset *Eupatorium altissimum* give a shaggy look to many of our Missouri fields. The plants branch widely and are covered with flower heads whose rich honey-like scent is one of the sweetest in any of our native wild flowers.

AN INVITATION TO SUGGEST NAMES FOR CLIMATRON FEATURES

THE lack of specific names for the different paths, walks, planting areas and ponds, is a handicap for all those working daily in the Climatron. The botanist on a collecting trip can say that he found a plant along the road to Mandalay, or on the seventh hill in Rome, or off the Alaskan Highway, but it sounds awkward to explain the corn in the Northwest sector and in the Southeast sector of the Climatron. How much nicer it would be to talk about the ginger on Misty Ridge, or the silk oak on Emerald Mountain.

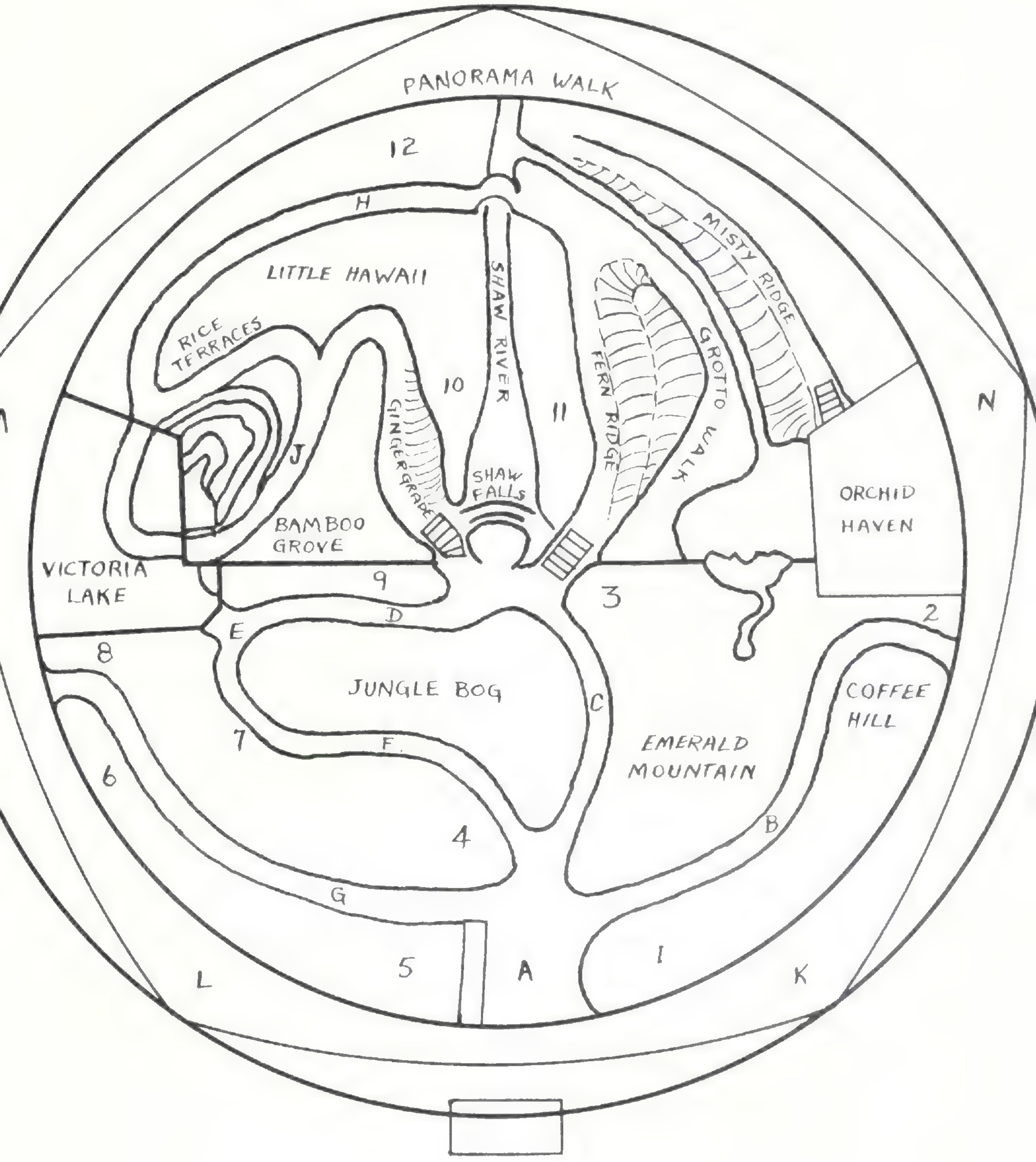
Definite areas with some suggested names are indicated in the accompanying sketch of the Climatron. The areas and the paths for which we should like to have names are indicated by numbers. Everyone is invited to think up the most interesting and catchy names for each of these areas and paths, and to send them to the Editor of the BULLETIN. You also may suggest new names for the areas which are already indicated by a name.

A small group of staff members of the Garden will review names which have been proposed and we promise to every person who has suggested a name which is accepted, a special orchid corsage to be delivered at the time of the preview for the Chrysanthemum Show. The names will be judged partly on the basis of euphony and appropriateness, but they also should suggest romance, mystery or any other quality which would make one long to visit the Climatron when such a name is mentioned. "Misty Ridge" on a hot summer day might evoke thoughts of coolness. "Floating Rock Pond" is both descriptive and appealing, "Victoria Lake" refers to the Victory Regia to be grown in it, but another name stressing the under-water walk might be better.

Everyone, including Garden employees, may compete for these prizes but we suggest that you get your inspiration for a new and catchy name, by walking through the Climatron frequently.

It should be made clear that in the course of the next few years fairly big changes will be made in the layout of the lower levels of the Climatron. The map shows that the center, where now the portico from the palm house was left standing, will be redeveloped into a rather craggy mountain from which a big waterfall will drop down. It should be big enough so that one can walk behind the water curtain. On each side of this mountain a long ridge will gradually grade down to the lower level with a more or less naturalistic set of steps instead of the formal stairs which are there at present. It seems appropriate to call this mountain "Shaw Mountain" and the waterfalls "Shaw Falls," but perhaps another name will be proposed. So now, go and get at it—this will be fun!

F.W.W.



PLAN OF THE PRESENT AND PROPOSED PLANTINGS
IN THE CLIMATRON

Letters refer to Paths and Walks to be Named

Numerals refer to Planting Areas to be Named or Renamed

HAY FEVER

JAMES A. DUKE AND J. TED BEST, M.D.

SIGHS of relief may be heard as the crisp autumn breezes cool the long suffering brows of summer. But among the sighs of the pleased may be heard the sneezes of those who don't appreciate the autumn breezes. These few are those who are suffering through the last of the three hay fever seasons, and although we have never experienced hay fever ourselves, we are led to believe that those who do are looking forward to winter when the flowers are no longer producing their pollen.

Hay fever knows three main seasons, the early spring, the early summer and the early fall. The first season corresponds with the flowering time of many of the wind-pollinated trees such as oak, elm and box elder, all of which abound in the St. Louis area. The early summer season corresponds to the flowering period of the grasses. The last season, which concerns us today, corresponds with the flowering period of several weedy elements of the Missouri flora. Just as the summer season has been blamed on the rose, the fall season has been blamed on the goldenrod, which is one of the most conspicuous flowers of that season.

It is true that if a sufferer should smell a rose or a goldenrod, at close range, he would in all probability, exhibit the symptoms of an attack, but both these plants are insect-pollinated. The real culprits are wind-pollinated plants whose flowers are inconspicuous and not attractive to people or to insects. To compensate for this they produce astounding quantities of nearly weightless pollen which is carried for great distances by the wind. By way of contrast, insect-pollinated plants generally produce lesser quantities of pollen which is heavier and more oily. In addition to the oil, many of them have spines which make them more likely to become attached to the marauding insects.

Pollen, although not in itself truly sexual in nature, is a minute cell produced by the stamens of the plant. Sperm are produced after a few nuclear divisions, some of which may take place while the pollen is still in the anther of the stamen, the remainder taking place after the pollen has been transported by one agent or another to the female parts of the flower. Although minute, the proteinaceous pollen grains often have very ornate walls, being provided with variously shaped spines which may aid in their dispersal. Although other agents such as dust, powder and lint, may be effective in inducing the symptoms of hay fever, pollen is one of the more common agents in autumn.

For a better understanding of hay fever, we should first understand a few of the principles of allergies.

Allergy or hypersensitivity in man is an adverse reaction produced by exposure to a foreign substance (antigen) following an initial or sensitizing contact. The body's response to such a contact is to produce a substance (antibody) which is capable of "neutralizing" the antigen. When the antigen and antibody unite within or

on the surface of the cell, histamine or a similar acting substance is released which in turn reacts on the cells of the shock organ (lungs, blood vessels, or in the case of hay fever on the mucous membranes of the upper respiratory tract). Thus, contact with an antigen which is usually protein in nature is a prerequisite for development of allergy, and hypersensitivity reactions are elicited only by re-exposure to the antigen or some closely related substance. Hypersensitivity itself is not inherited but the existence of a genetic predisposition to development of allergy seems firmly established.

Hay fever is an allergic disease of man characterized by sneezing, copious mucus discharge from the nose, and itching of the eyes, often accompanied by tear formation. It is usually seasonal since sensitivity to air-borne antigens, particularly pollens, is by far the most common cause. The diagnosis is established when, by injecting under the skin small amounts of extracts from various of the common offenders, a reaction is obtained to one of the substances known to be present in the atmosphere at a time when the patient displays symptoms. The most important single preventative measure would be to remove the antigen from the patient's environment or conversely, to remove the person from the environment of the antigen, but this is usually unfeasible or impossible. Small amounts of the offending antigen may be injected into the patient over a long period of time until all the offending antibodies are removed from free circulation within the blood. Any additional antigens can find no antibodies to react with as they have all been neutralized in antigen-antibody reaction. Although this is theoretically sound, clinically it is often unsuccessful and indeed may be also unfeasible as most people are not sensitive to one but many substances. In the acute attacks antihistamines are used to counter the effects of the histamine-like substances released in the antigen-antibody reaction. Adrenal steroid hormones such as cortisone afford relief through their anti-inflammatory activity. The use of such powerful drugs is deplored by many physicians because hay fever is a benign disease, principally uncomfortable and annoying to the afflicted person, but never fatal.

Although the hay fever sufferer will certainly not wish to study his enemies at close range, he should be able to recognize them so that they might be avoided. The worst offender in the fall season are inconspicuous weeds, close relatives of the more striking goldenrod. Most common in Missouri are the ragworts or ragweeds *(Ambrosia)*, the cockleburrs *(Xanthium)*, the marsh elders *(Iva)*, and the burr ragweeds *(Franseria)*. These are all members of the aster family which has some of the most complicated flower-arrangements in existence. The intricacies of these flowers was the subject of an article in the April issue of the BULLETIN. The principal fall hay fever plants may be distinguished by the key below.

a. Flower heads without spines, not burr like ..... Iva
a. Flower heads with spines, burr-like.
  b. Spines all pointing in one direction ..... Ambrosia
  b. Spines pointing in all directions.

c. Leaves fern-like; burrs ca. ¼ inch long ..... Franseria
c. Leaves maple-like; burrs about an inch long ..... Xanthium

1. *Iva:* Marsh Elder. These are shrubby plants which differ from the following in having both male and female flowers in the same flower cluster. Three species are common in Missouri: *Iva angustifolia*, with willow-like leaves, *Iva annua* with leaves shaped like an elm but with fewer teeth, and *Iva xanthifolia*, with maple-shaped leaves. The heads which are not burr-like at all, are in spike-like inflorescences in the first two species, but they are in broad branching inflorescences in *Iva xanthifolia*. The pollen grains have small spines and are about 20 microns in diameter. All the Missouri species are hay fever agents.

2. *Ambrosia:* Ragweed. The ragweeds are perhaps the worst offenders in Missouri. They often form dense head-high thickets; brushing through them could prove disastrous to the hay fever sufferer. Four species are common in Missouri and they can usually be distinguished by the leaves. *Ambrosia artemisifolia* and *A. psilostachya* have fern-like leaves, but in the latter, the upper surface of the leaves are harsh to the touch and the fruits rarely have tubercles at the tip. In the former, the leaves are not harsh to the touch and the fruit is crowned by 4–7 spines all oriented in the same direction. *A. trifida* has broad leaves which are three-lobed whereas *A. bidentata*, with which it hybridizes, has narrow willow-like leaves which often have a couple of minute teeth at their base. The pollen grains of these forms are about the same size as those of *Iva* but the spines are not so prominent. The male and female heads occur in separate clusters on the same plants, the male heads which produce the pollen being terminal on the spike-like branches of the inflorescence.

3. *Franseria:* Burr Ragweed. As the true ragweeds, the burr ragweeds are serious sources of irritation. They closely resemble the true ragweeds in many respects, but the spines on their burrs tend to be oriented in a less orderly fashion. I have seen specimens of only one species, *Franseria acanthicarpa*, from Missouri, but members of this genus and other related genera may appear as weeds rather spontaneously; e.g. *Franseria discolor*, normally of more western distribution, may have established itself in Illinois. The pollen grains are about the same size as those of the preceding genera but the spines are smaller and tend to be more remote from each other. The culpable male heads tend to be located at the ends of the branches, above the burrs, which are in turn located in the axils of the uppermost fern-like leaves.

4. *Xanthium:* Cockleburr. Offensive in more ways than one, the cockleburrs are heavy pollen producers, serious weeds in cotton and corn fields, and too many of us know how annoying they can be as they cling to the socks. The spines on the burrs have minutely but obviously recurved tips which tend to hook into fur or clothing. The efficacy of this means of seed dispersal is reflected by the wide distribution of these species, several of which have been introduced from other continents.

1. *Iva* Marsh Elder

2. *Ambrosia* Ragweed

3. *Franseria* Burr Ragweed

4. *Xanthium* Cockleburr

PHOTOS BY K.O.P.

Xanthium italicum and *X. chinense*, two of the many species found in Missouri, serve by their names alone to suggest the ubiquity of cockleburrs. The pollen grains in many cases are half again as large as those of the preceding genera, but the size and placement of the spines tend to vary, in some being larger and farther apart, others approaching those of the previ-

ous genera in their size and distribution. The leaves of these plants are different from any of those (except *I. xanthifolia*) in being more or less like a maple. In the boot-heel of Missouri, the leaves of this weedy plant closely resemble those of the cotton, which it often crowds rather deleteriously. As a rule, the male inflorescences are borne on different branch systems of the same plant. Our species are mostly annual, and were it not for an annual increment of seeds, they could soon be eliminated. Nevertheless, it remains one of the worst of Missouri weeds and a real nuisance to the hunter and naturalist, whether he has hay fever or not.

BOOK REVIEW

Gardens in Winter, Elizabeth Lawrence, 218 pp., $4.50, Harper & Bros. 1961.

Some years ago Miss Lawrence wrote a book called *A Southern Garden*, largely about her own garden in Raleigh, North Carolina. One section described her attempts to find hardy things which would flower late in the fall and early in the spring as well as to locate genuine winter-flowering species such as the Ozark Witch Hazel, *Hamamelis vernalis*. Her description of her successes and failures was so fascinating and so filled with odd bits of information, practical and otherwise, about these unusual and mostly little known plants, that many of her readers became personal friends, at least by correspondence. In the meantime *A Southern Garden* has gone out of print (though it won the Herbert Medal), Miss Lawrence has moved from Raleigh to Charlotte, and has contrived another garden with a strong accent on winter bloom. During all this time her correspondence with other enthusiastic gardeners has continued, so that she writes not merely in terms of her own two North Carolina gardens but with many a detailed reference to the experience of Carl Starker in Oregon, Mr. Krippendorf in Cincinnati, and Caroline Dorman in Louisiana. These and a host of other friends appear on page after page, their experiences and their likes and dislikes, compared and contrasted with her own.

It is doubtful if a horticultural book more truly national in tone and content has ever been produced in this country. St. Louisans interested in gardening throughout the year will be envious of her experiences in Raleigh and Charlotte where cold waves arrive more gently and occur less frequently than with us. Though our best gardeners can read it with profit, large parts of Miss Lawrence's new book, *Gardens in Winter*, must remain for us something of a dream book, a mark to shoot at. She writes for instance of *Mahonia Bealei*: "With me the flowers usually begin to open in late January * * * They are never frost bitten." A St. Louisan knows that though a light frost does not injure them, they are killed outright by a heavy freeze. My own plants are in a sheltered spot, yet in many seasons the flower buds are gone before they open and in more

favorable years I have had to be content with fleeting glances of their fragrant pale yellow beauty and to be thankful that the handsome holly-ish leaves have never yet been injured.

Along with enthusiasm and vivid description, moreover, a lot of honest practical advice is packed into this little book of 218 pages. In her discussion of the winter aconite, for instance, it is helpful (and comforting) for those of us who have more or less failed in establishing this beautiful winter flower in our gardens, to read, "Once well started, the winter aconite is in the garden for life, but getting it above the ground the first time is not so easy. The problem is to get fresh tubers, for they suffer if they have been allowed to dry out. Mine came from Mr. Krippendorf, who sent them in bloom; great clumps cut like turf, with the woods earth undisturbed. Caroline's came from Alexander Heimlich (in Massachusetts) who keeps his tubers in damp peat moss until they are shipped. Sometimes it is hard to tell the top of the tubers from the bottom. Putting them in edgewise seems to solve this problem. Aconites want some shade and they do well under tall trees, where they should be planted by the hundreds to make a sheet of early bloom."

Gardens in Winter is attractively printed, with 27 line drawings by Caroline Dorman, which combine botanical understanding with gardening insight and decorative charm. There is a full index, not only to the plants but to the regions about which there is definite information and to the many friends and authorities who are quoted. There is an imaginative list of suggestions for winter reading and two full pages of addresses of the firms (some large, some very small) who can supply plants, bulbs, and seeds.

E. A.

MISSOURI BOTANICAL GARDEN PROGRAMS

For Further Information Telephone TOwnsend 5-0440

SPECIAL SHOWS AND DISPLAYS

Greater St. Louis Cactus Show, September 2 through 10.
St. Louis Horticultural Society Harvest Show, September 16 and 17.
Midwest Dahlia Show, September 23 and 24.
Live Concert in the Knolls by a Chamber Group of the St. Louis Symphony Musicians, October 14

FREE NATURE PROGRAMS FOR CHILDREN, aged seven and over, are held every Saturday morning from 10:00 to 11:30 A. M. Meet in Museum Bldg.

September 2 Plants for the House
9 Hundred in One Flower
16 Color Sound Movies
23 The Devil's Footstools
30 From Dust to Seed

COURSES FOR ADULTS beginning in September and corrections for those beginning in October.

105 How to Propagate from Cuttings—5 sessions—fee $12.00.
Tuesdays October 17 to November 14—8:00 to 9:30 P. M.
Thursdays October 19 to November 16—1:00 to 2:30 P. M.

Fundamental facts and procedures for producing trees, shrubs, and perennials from cuttings (asexual reproduction). The Garden will supply one plastic covered metal propagating flat, media and plant materials for 40 to 50 kinds of plants.

107 Bulbs, Indoors-Outdoors—2 sessions—fee $8.00.
Tuesdays October 3 and 10—8:00 to 9:30 P. M.
Thursdays October 5 and 12—1:00 to 2:30 P. M.

Instruction on bulb forcing and outdoor bulb culture will be given. The Garden will supply each student with 24 top quality bulbs in 7 inch clay pans which may be taken home. The Garden will also provide space for the cool treatment which the forced bulbs require.

108 House Plants—3 sessions—fee $6.00.
Thursdays October 5, 19 and 26—8:00 to 9:30 P. M.

General instruction in kinds of house plants, care and growing requirements such as heat, light, water and fertilizer will be given. Attention will be given to individual home problems.

205 Field Botany—Fall—3 sessions—fee $6.00.
Saturdays September 23, 30 and October 7. Start from the Garden—10:00 A. M.

Field courses are designed to enable the student to recognize common wild flowers and weeds in the Fall, and to understand plants' relationship to their environment.

207 Mosses and Ferns—5 sessions—fee $10.00.
Wednesdays October 4, 11, 18 and 25, November 1—8:00 to 9:30 P. M.

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SOME FACTS ABOUT SHAW'S GARDEN

The Missouri Botanical (Shaw's) Garden was established in 1859 by Henry Shaw, a St. Louis businessman, to be controlled by a Board of Trustees for the public benefit. The Garden is a non-profit institution which receives no support from the city or state, depending on the income from the Shaw estate supplemented by contributions from the public.

The old stone walls and cast-iron fences, the Linnean House, the Museum Building, the part of the Administration Building which was Shaw's Town House, relocated in the Garden in 1890, and the Tower Grove House, his country home, all date from Mr. Shaw's time. The Main Gate, display and growing greenhouses and most other facilities date from the period immediately following the turn of the century. The Climatron, opened in 1960, is the first of several new buildings planned for the Garden's redevelopment. It is the world's first geodesic dome, fully climate-controlled greenhouse and contains the Garden's tropical collections.

The Garden—70 acres—is open every day of the year from 9:00 A. M. until sundown; the greenhouses 9:00 A. M. to 5:00 P. M.; the Climatron Monday through Thursday 9:00 A. M. to 6:00 P. M., Friday through Sunday 9:00 A. M. to 10:00 P. M. (April through October); Tower Grove House is open daily from 10:00 A. M. to 4:00 P. M. (December to March on weekends only). The Display House presents four seasonal displays: November, Chrysanthemums; December, Poinsettias; February, Orchids; Spring, Lilies and other flowers. During the year are other shows, competitions and festivals sponsored by various Garden Clubs and Flower Societies.

Courses in Botany and Horticulture for adults are conducted by the Garden staff. Children's nature studies are provided each Saturday of the year and a special nature program is held during the summer. Information on these activities is published in the BULLETIN or may be had by mail or phone. The Garden maintains a research program through the Henry Shaw School of Botany, Washington University.

In 1926 an Arboretum — 1600 acres — was established at Gray Summit, Missouri. Foot trails and roads pass through the Arboretum and are open to visitors in April and May.

The Garden Administration Building is located at 2315 Tower Grove Ave., and the Garden main entrance is at Tower Grove and Flora Place. The entrance at Tower Grove and Cleveland Avenue is also open to the public. The Garden is served by both the Sarah (No. 42) and the Park-Southampton (No. 80) city bus lines.

Persons interested in helping to support the Garden and taking part in Garden activities are urged to do so through the "Friends of the Garden". Information may be obtained from the Main Gate or by mail or phone.

MISSOURI BOTANICAL GARDEN

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COVER: Dwarf Norway Spruce—8 years. Photo by Peter Michael Genovese.

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DWARFED POTTED TREES

ANN KIMBALL PIPE

TREES growing as dwarfs or miniatures in our homes can be delightful and an exceedingly fascinating hobby. The art of bonsai or dwarfed potted trees is an ancient Japanese horticultural achievement developed over centuries of patient and tireless effort.

Reading the five or six books on the subject available today can be a most discouraging experience unless you have already tried your hand at dwarfing trees. If you have, you know that while it presents a challenge, it is not as difficult as it sounds. You wonder what you are getting into when you are told that the best soil for growing bonsai is a hard substratum found only in Japan and that this should be pulverized, sifted, then sorted, picking out only such grains that are "of uniform size of about one millimeter." You wonder, too, when you read that bonsai should be left outdoors all winter, if the author who lives either in Japan or California, has taken into consideration our midwestern winters. In past springs I have had a generous heap of small, dead trees to indicate he has not, and that special overwintering care must be given for our more severe conditions. These books are, of course, invaluable, and as you advance you will need to know much of the information they contain, but not necessarily from the beginning.

It is not the purpose of this article, since space is limited, to discuss fully the shaping of the tree to create beauty and the illusion of age. That is an art in itself, a matter of individual taste and experience, of the passing of many pleasant hours studying pictures of the venerable bonsai of Japan, and of considering how the natural shapes of your own trees can best be dramatized. All of this will come later, but as a start you have only to obtain a few small trees and plant them in pots. Then you must learn enough about their needs to keep them alive and healthy. This is our immediate problem.

CHOOSING A TREE

I know of no tree that cannot be dwarfed successfully, but since trunks and limbs become stunted more readily than do leaves, fruits and flowers, the problem will be simplified if you start with a small-leaved tree or shrub. Then, if you are a beginner, it is best to choose one that is winter hardy and will stand a fair amount of abuse. This by no means implies that such a tree is less desirable, for some of the finest ancient bonsai of Japan belong to this group.

Mrs. E. H. Pipe is an amateur bonsai enthusiast in St. Louis. Pictures with the text are taken from her collection by Peter Michael Genovese.

Trees suitable for dwarfing may be started from seed, or from cuttings or layering; they may be found in your own yard, in fields or woods (already dwarfed if you are very fortunate), or they may be purchased from nurseries, preferably in the convenient one-gallon can sizes. You will probably use several of these sources as you go along, but shopping in local nurseries offers the best opportunity for starting with a tree that can be given the appearance of a true bonsai long before the dwarfing process has developed to the point where it may accurately be given the name.

While it is not possible to list here all of the easy-to-grow varieties which may be found locally, a few of the most outstanding should be mentioned. Among the conifers I would head the list with any of the junipers which may be found in great variety in almost any nursery. Second, a little more difficult to handle but not too much so, are the hardy pines, especially the Swiss Mountain Pine *(Pinus mugo)* because of its compact habit, the Japanese Black Pine *(Pinus thunbergii)*, a popular bonsai subject for hundreds of years, or any of the hardy stone pines with their habit of growing in pleasing, angular shapes. For flowering and fruit the Firethorn *(Pyracantha)* would head the list, with its white spring flowers, its brilliant fall berries, and its very accommodating habit of living through even the most adverse conditions. Next I would name the flowering quince *(Chaenomeles)*, especially the Dwarf Japanese Quince *(C. japonica)*. Among the broadleaf evergreens, box *(Buxus)* is very easy to handle, and the Korean Box *(B. microphylla koreana)* with its very small leaves is especially attractive.

Almost any of the hardy deciduous trees grow equally well in pots, although those of suitably small size are a little more difficult to find in local nurseries than are the conifers. A taller deciduous tree may be cut back drastically in early spring, however, if you find one which branches low enough on the trunk.

Seedlings of deciduous trees such as maples, locusts, mulberries, elms and the like are readily found in a neighborhood where mature trees of the species are growing. Planting them in a corner of your garden for the first few years will speed their growth, although they should be lifted from the ground each spring, and their roots and tops trimmed back a little to keep them within bounds.

Do not limit yourself to these suggestions, however. Hunting for suitable trees is half the fun of growing bonsai, and there is no thrill quite like that of finding one, of whatever

Swiss Mountain Pine 10 years. This tree was growing in a nursery eighteen months ago.

variety, with a really unusual shape or a wonderfully gnarled and twisted trunk. The latter is of particular importance, for even though it may be all but obscured in the nursery by heavy growth, its line will be revealed as you prune and shape the branches, and will eventually become the most important feature of your tree.

Remember that even though you are starting out with a tree which is new to you, it is encouraging and not at all unusual to find good nursery specimens which are already eight or ten years old when you buy them. See, for example, the illustration of a ten-year-old Swiss Mountain Pine which was growing in a nursery only eighteen months ago. It is already well on its way to becoming a most attractive dwarfed tree, evidence that, contrary to widespread belief, it does not take a lifetime to acquire a collection of which you may be justly proud.

Pomegranate Trees from seed sown at the same time. Container sizes have controlled tree sizes.

Potting and Root Trimming

For the first potting it is best, in some instances, not to plant your new tree in the decorative container it will eventually deserve. There are several reasons for this. 1. The container is a very important part of bonsai and should be chosen with care, keeping in mind the characteristics of the particular tree that will go into it. A tree fresh from the nursery will not show these characteristics to any but a trained eye, and until it has been pruned and shaped it is difficult to know whether a rectangular, round or oval pot will be best, or whether it should be deep or shallow. 2. A successful bonsai is one in which the fewest possible roots support the largest possible trunk and branches. A small tree which has been planted in a large, roomy container is not a bonsai at all, but merely a potted tree. If your new tree has a large root ball, it may be reduced in size more safely by a series of repottings, moving the tree to a smaller container each time. Cutting away too many unwanted roots in one operation can sometimes result in disaster. 3. If your new tree is not as large as you would like it to be, giving it a little extra growing room for a while will allow it to increase in size in a comparatively short time. In the accompanying illustration two pomegranate trees are shown, each grown from seed less than three years ago. They were grown under the same conditions, yet one is still only a few inches high because of its smaller container. In selecting a pot size, be guided by how much you want your tree to grow in the first year or two.

When you have chosen a suitable pot, prepare it by covering the drainage hole with a stone or small square of aluminum screening. Then, if it is a deep one, add an inch or so of gravel to facilitate drainage. Next add a layer of potting soil which you will have prepared beforehand. A potting mixture of equal parts of sifted leaf-mold, topsoil and sharp sand will suit the needs of almost any tree, although there are many other recommended mixtures with which you may want to experiment later on.

Remove your tree from its container or package, choosing a protected, shady spot in which to work to prevent drying out of the roots. With a pointed stick, pick away enough of the soil so that the remaining root ball is a little smaller than the pot into which it must be fitted. Using sharp scissors, cut off the roots thus exposed. You may safely remove from one-fourth to one-third of the total root structure for this first potting. A young tree up to ten years old will tolerate more root-trimming than will an older one, and the roots of most deciduous trees may be cut back, in the proper season, even more severely.

Place the tree in its pot and fill the pot with soil, pushing it down carefully with your stick until you are sure there are no air pockets left. Then water thoroughly, several times, until moisture is seen coming through the drainage hole at the bottom. All that remains to be done to establish your tree in its new home is to protect it from the sun and wind for a few weeks.

Although the same general procedure is followed for repotting the tree when it becomes necessary in future years, it will be helpful if you understand that the primary function of root-trimming is to make possible the growing of a tree in the same container year after year without its becoming so root-bound that it will eventually starve to death. Tree growth could be controlled more readily if the roots did not have to be trimmed at all. Since the cutting off of fresh, new roots encourages rank growth, it is best, therefore, to be as selective as possible in root-trimming after the tree has reached the size and shape you would like it to maintain. With some species it is difficult to distinguish between old and new roots, but when there is an obvious choice, leave untouched as many new roots as possible, and trim off only the brown, dead ones.

If any one consideration is of paramount importance for the inexperienced grower, it is the time chosen for repotting. It is an exaggeration, but not a great one, to say that it is impossible to kill a tree by judicious trimming of its roots if it is done at the proper time, and the statement comes even closer to the truth in the case of a young, deciduous tree.

In early spring, probably in March or early April depending on the species and where it has spent the winter, examine the buds on the branches. If they show signs of swelling, with just a hint of green at the tips, tap your tree out of its pot and examine the roots. If they are crowded, winding around to follow the shape of the pot

with little soil showing, it is time for repotting.

Although most books on the subject give a rather set schedule for repotting (conifers every three to five years, deciduous two to three years, fruiting and flowering every year), there are too many factors involved to make such rules practicable. A young tree grows faster than an old one, some species faster than others, and a small or shallow container will become crowded more quickly than will a deeper one. It is best, therefore, to check each tree for its individual needs, although in the case of a slow-growing tree, a mature tree, or one in a fairly large container, this need not be done every year.

Repotting in early fall, at the start of a new growth period, is perfectly safe for some trees, and even preferable with fruit trees that bloom in early spring, but for the beginner, working with the types of trees mentioned, early spring potting is his best insurance against failure.

Some species of trees have very few fiber roots, and in such cases the soil has a tendency to fall away from the roots during transplanting. This should be avoided whenever possible, particularly in the case of a tree which is being moved from the open ground for the first time. It is far preferable to keep a ball of earth intact at the base of the trunk and to cut off the long side roots than it is to expose all the roots even though none of them are damaged in the process.

If a tree shows signs that its roots have been damaged too severely during transplanting, it may often be saved by treating it just as you would a new cutting. Plant it in sand, protect it from direct sunlight, keep it moist, not wet, and do not attempt to feed or prune it until you are sure new root growth has started. Then you may transplant it back into soil, but it still must not be fed or pruned until it has shown signs that the new roots are continuing to grow. If you find a mature, naturally dwarfed tree in the fields or woods, remember that it cannot be transplanted as easily as a nursery-grown tree. For this reason it is often wise to treat it in the above manner at first, especially if you have reason to believe its root system is not in good condition.

Watering

There is one very popular book on bonsai which gives instructions on how to plant a tree in a container with no drainage holes. My best advice is not to try this, for the importance of good drainage cannot be stressed too much. It is next to impossible to overwater a dwarfed tree in sunny, hot weather if the drainage is good, as it must be. Whether the tree in midsummer is watered once a day, or twice, or three or four times depends on the size of the container and the type of tree you are growing. If you are not at home much of the day, avoid very shallow containers; then a morning and evening watering should be sufficient. Just be sure, as you would with most other potted plants, that the soil does not remain in a dried-out condition for too many hours, for if it does, irreparable damage may be done. When you do water,

remember that one thorough soaking in hot weather is preferable to two or three light sprinklings, and that the trees will also appreciate an occasional spraying of their leaves after the sun has set.

In winter, of course, watering should be done less often; once or twice a week should be sufficient, again depending on the size of the container and the location of the tree. Water only when the soil seems to be dry, giving just enough to dampen, not soak it thoroughly.

Do not be alarmed when you read that only rain water should be used on your trees. As a Japanese friend told me when I asked about this, "There is good and better and best." Rain water is best, but accumulating it is highly impracticable for most of us, and ordinary tap water is quite good enough.

Winter and Summer Protection

Here again there is much divergence of opinion, but since our Missouri climate with its extreme heat and cold creates special problems, I have found that some protection from full summer sun, and more than the usually recommended winter protection give the best results.

Although some trees do well in our full sun, most do not. A slatted shade, with the spaces between the slats approximately equal to the width of the slats, gives about the right amount of protection. Placing the trees to receive only the morning sun, or on a bench under a large tree where they will receive dappled sunshine, is also satisfactory.

Insufficient summer protection may cause browned leaves and an unhealthy condition which is temporary and seldom fatal. Insufficient winter protection may cause such excessive loss of trees as to discourage the beginner from proceeding—which almost happened to me three winters in a row. I tried most of the recommended methods, protecting the trees using coverings of wood, plastic and burlap, or combinations of these, with one end of the benches left open to admit fresh air. I had read that the real danger was from frozen, broken pots with the resulting root damage. However, all of my pots, many of them holding dead trees, remained unbroken through the winter.

Since hardy trees must have a resting period, including a certain amount of cold weather, they cannot be kept in a warm house during the winter months. An enclosed, unheated room, however, has proved to serve the purpose very nicely. This may be inside the house, either upstairs or in the basement, an enclosed porch, or a separate building such as a shed.

If you are growing only deciduous trees, the matter of light is unimportant, but conifers and broadleaf evergreens should be placed near a window, out of the direct sun, to receive as much winter light as possible.

Except under the above conditions bonsai should never be kept indoors for long periods, but this should not discourage even apartment dwellers, some of whom have been growing certain kinds of these trees successfully in this area for years. Bring your trees indoors to enjoy them, but keep them rotating so that none will spend

more than two or three days at a time in the house.

Feeding

There are almost as many recommendations on this subject as there are bonsai growers. They range from suggestions for giving weekly summer feedings to giving no food at all. Japanese experts, who possess more knowledge and experience than most of us will ever have, usually follow the latter course when working with trees which have already reached maturity.

As with most things, the middle course seems to be the best, and until you learn from experience the requirements of your individual trees, two or three feedings a year, in spring and early fall, with an optional one in midsummer, should suffice. Trees which flower or fruit in early spring will appreciate an extra feeding in the fall. No tree should be fed immediately preceding or during its dormant period.

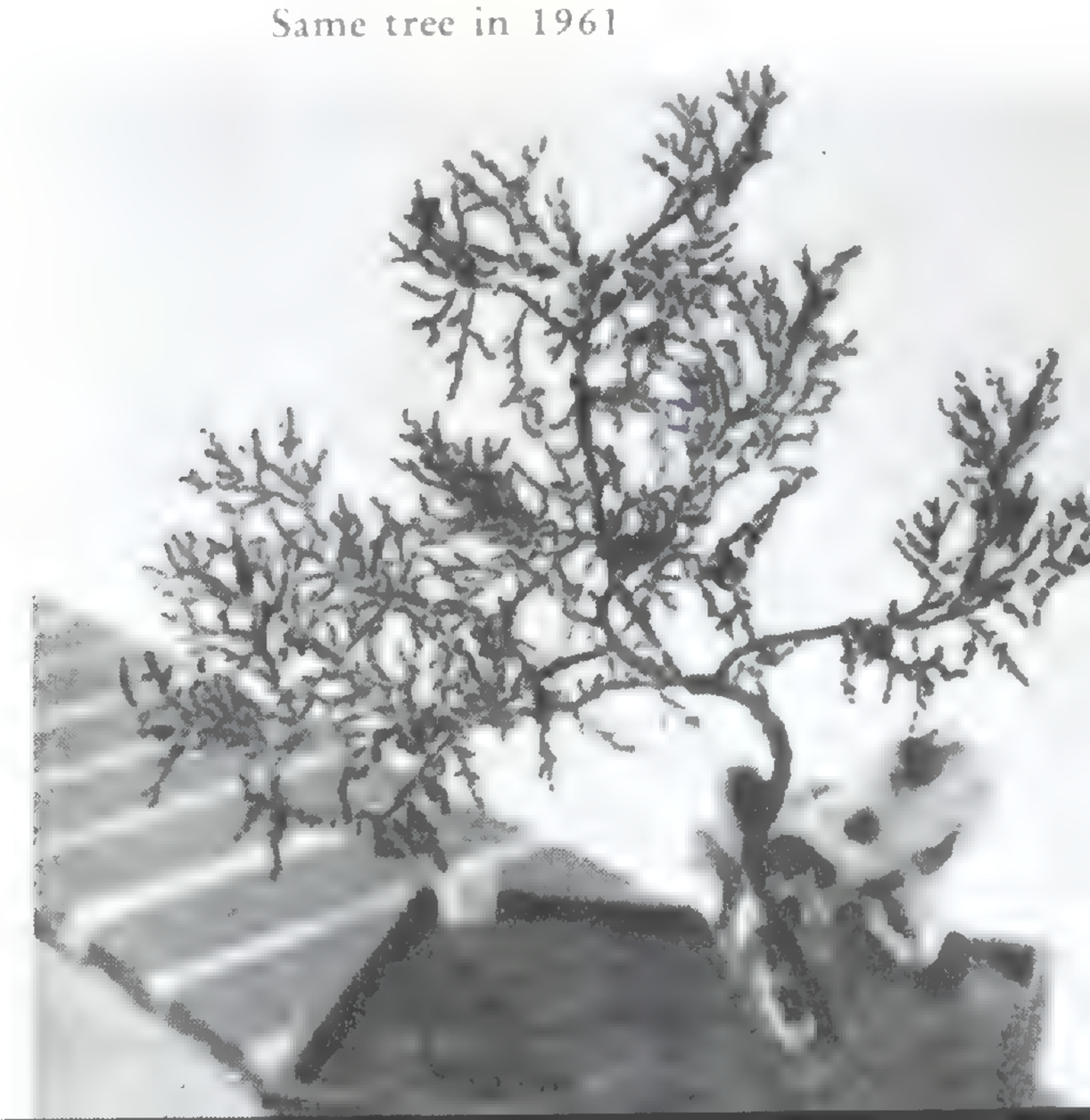
Almost any natural plant food will do. Diluted liquid manure, rapeseed meal, cottonseed meal, fish oil, or mixtures containing bone meal are a few of the acceptable ones. Avoid commercial fertilizers which are strong, or which tend to act quickly and may cause rank growth. No matter which food you select, remember always to feed sparingly.

A word of caution—keep in mind that plant food is a steak dinner, not a medicine, and should be given only to a good, healthy tree. One which has recently been repotted should be

Pfitzer Juniper in 1959

Same tree in 1960

Same tree in 1961



given at least a month's rest before it is fed, and food is more apt to kill than cure a sickly or diseased tree.

Pruning and Shaping

This is simply the art of encouraging your small trees to take on the appearance of their larger counterparts, and the closer the resemblance in every detail, the more successful the bonsai. Age is a most important factor in bonsai, and since none of us will ever grow a dwarfed tree a hundred or more years old, we do what we can to create the illusion of age. In studying the shape of a very old natural tree, for example, you will notice that the lower branches are usually growing either parallel to the ground or downwards, but seldom upwards as do similar branches of a tree only a few years old. Training the branches of your miniature tree to grow in the same way is a simple matter, and will do much to give the impression of advanced age.

Moss as a ground cover is an excellent means of adding illusory years to your tree, and it is not difficult to find in shady, damp areas in almost any lawn. If you find more than you have immediate need for, it may be dried, powdered and stored in jars for future use. A light sprinkling of powdered moss on the soil of a newly potted tree will soon reward you with a thick, green carpet which will not only enhance the beauty of your tree, but will serve to retain moisture and to prevent the soil from being washed away by heavy rains.

A bent or twisted trunk can be most attractive, but it should be encouraged only if the tree is of a species which would grow that way naturally. Distorted, monstrous shapes, fashionable more than a hundred years ago in Japan, are no longer considered desirable unless they reproduce the character of the adult of the particular species.

Once you have found your trees and potted them, there is no need for haste in deciding what you would like their final shapes to be. Take plenty of time, studying the best features of each, for you will want to emphasize these. Since even a dead branch may serve to add to the beauty of your tree, think twice before you prune, for a branch once removed obviously cannot be replaced.

When you are sure a branch is unwanted, cut it off as close to the trunk as possible, for an unsightly stub will mar the finished appearance of the tree. I have found that covering the large, fresh cuts with pitch is helpful not only in preventing disease from entering through the unhealed wound and in keeping the sap from bleeding through, but also in concealing the conspicuous white scar until nature has had time to cover it with a fresh layer of bark.

In changing the shape or angle of a branch do not be bound too closely by the instructions on wiring you will read as you go along. The purpose of wiring is to hold a branch in a desired position until it stays there permanently. Anything you do to this end which does not injure the tree is perfectly satisfactory. I have found, for example, that it is a simple matter, in lowering a very heavy branch, to pull it down to position by tying one end

of a length of plastic-covered wire to it, bringing the wire down under the pot, and securing the other end to the base of the trunk on the opposite side. If two branches are growing too close together, it is easier to separate them with a short stick than it is to wire them.

Scarlet Amur Maple Forest about 5 years

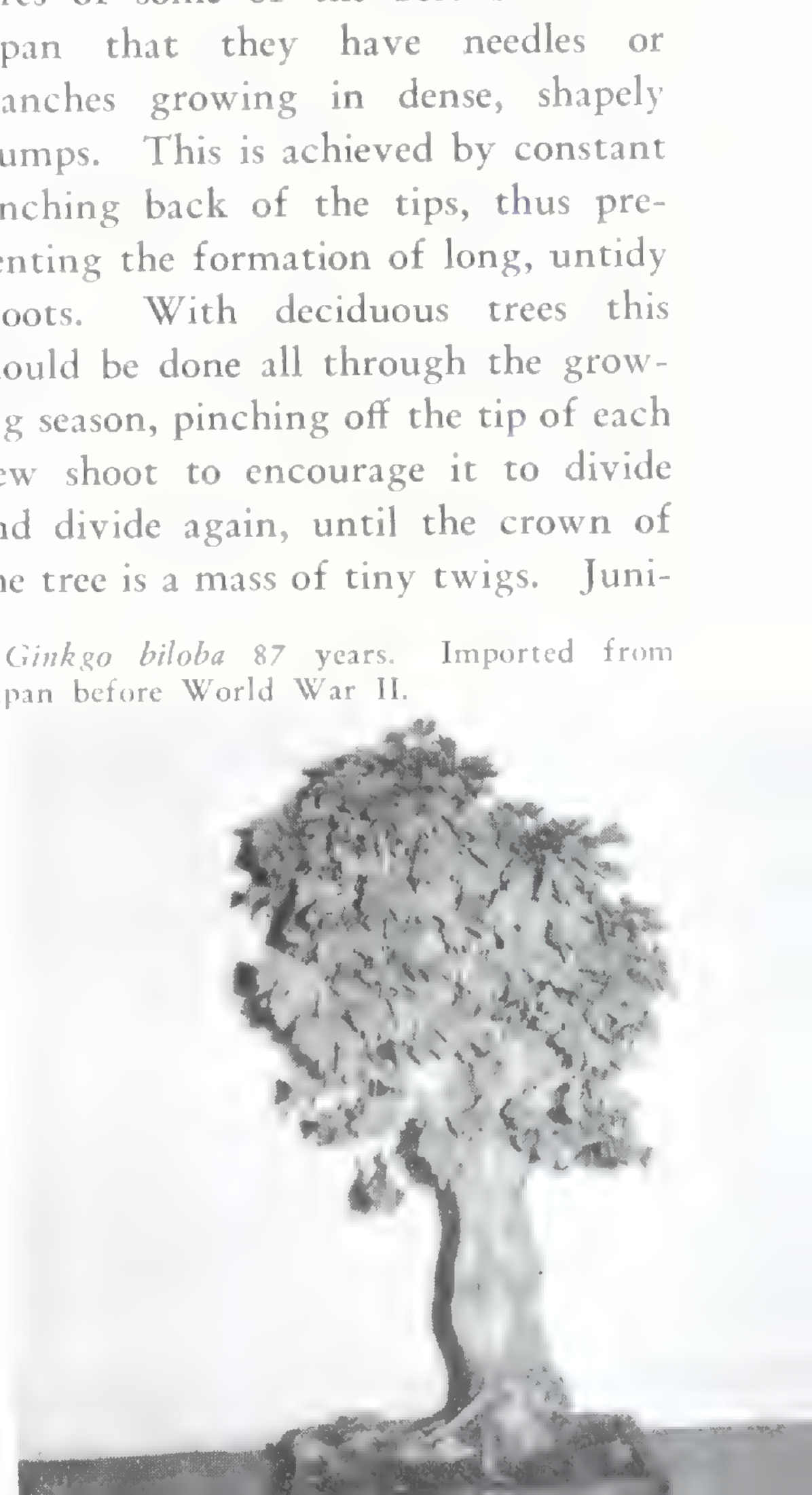
When wiring seems advisable, loop one end of the wire around the base of the branch, then coil it, not too tightly, around the branch all the way to the tip. Bend to the desired position.

For pruning, I find my most useful tool is a pair of ordinary nail clippers, the kind with short, curved blades and handles which spring apart automatically. With these, a small saw and a pair of garden pruning shears you will be able to make any necessary cut. A selection of rust-proof wires of various weights, wire clippers and plastic ties or stout cords will complete all the equipment you will need for this phase of the work.

Wires and ties should be left in place as long as necessary, up to about a year. A young branch will become fixed in its new position in the short time which it takes the wood to mature. A heavier branch may take six months and a very heavy one a year or more. Wires are usually removed at the end of a year even though setting of the branches may not have been completed, for if left on too long they may leave permanent ridges in the bark. A branch may be rewired if it is still necessary, but care should be taken that the new wire does not touch the wood in the same places as did the old one.

You will notice in studying the pictures of some of the best bonsai of Japan that they have needles or branches growing in dense, shapely clumps. This is achieved by constant pinching back of the tips, thus preventing the formation of long, untidy shoots. With deciduous trees this should be done all through the growing season, pinching off the tip of each new shoot to encourage it to divide and divide again, until the crown of the tree is a mass of tiny twigs. Juni-

Ginkgo biloba 87 years. Imported from Japan before World War II.



pers and other conifers which grow off and on during the spring and summer months should be treated in much the same way; the unwanted growth is taken off as it appears. Pines, however, which usually put on a whole year's growth only in spring, should be handled differently. Wait until the light green, candle-like shoots are partly open, then twist off the greater portion of each, leaving only a few needles at the base. Experience will teach you how much to remove, for you will not want to hold back the growth of a very young tree as severely as one which has already reached the desired size.

It is best to be very cautious in the use of stones, driftwood and other extraneous decorating material, for most of these serve only to detract from the tree itself. The creating of miniature scenes by the addition of small figures, houses, bridges and the like is a separate art, called *bonkei,* but in bonsai the tree is all-important and nothing should be added that will mar its beauty and simplicity. If a stone is used, it should be appropriate to the variety of tree with which it is placed. A heap of water-smoothed stones, for example, at the base of a tree normally found growing in a green meadow would be incongruous. In making decorative additions, keep in mind that too little is better than too much, and that none at all is seldom a mistake.

It is hoped that the brief points given here will start you off on a hobby that is of continuing fascination. Do not regard the loss of an occasional tree as a sign of failure. Some loss may be expected at first, the tuition fee you will pay for learning, for after you have selected and potted your trees the study of bonsai is just beginning for you. There is no such thing as a grower of bonsai who is not also a bonsai enthusiast, and since it is not possible for any one person to learn all there is to know about these small trees, there will be many years of exciting and satisfying work ahead of you.

I should like to express my indebtedness to my friend, Mr. Nonkey T. Ishiyama of McLean, Virginia, who has generously and patiently taught me, over a period of several years, much that has gone into this article.

PHYSIOLOGICAL FACTORS INVOLVED IN DWARFING TREES

GROWING of dwarf trees is a remarkable problem for the theoretical botanist. It is his usual problem —how plants grow—in reverse. For it is a question as to how one can make conditions so unfavorable that the plant will grow hardly at all. Therefore I would like to comment on some of the cultural practices, which Mrs. Pipe discusses in the interesting foregoing article on bonsai trees.

For good growth one needs good soil, good nutrition, plenty of water, vigorous plants and good environmental conditions. For a bonsai tree one has to choose the opposite conditions. First, soil. Take the poorest you can get, which will not hold much

water and still less nutrients. In such a soil the plant will develop a poor rootsystem, which is important, since a large number of roots with lots of roothairs are a necessity for good growth. Therefore, severe root pruning is also a good idea to hold back growth. A plant without roots no longer grows, as demonstrated by flowers kept in a vase. It seems that roots and especially roothairs produce a hormone necessary for stem growth. Hence, the fewer roots, the less hormone and the less growth. But a plant which does not grow at all will die as soon as its leaf cells have reached their maximum age limit, which is usually about a year. Therefore one should allow enough roots on the bonsai plant to allow a minimal amount of growth.

The less water a plant gets, the less it grows, but this is difficult to control, for once the plant has severely wilted, it usually dies. But by using as little nutrition as possible, growth can also be reduced. This is the reason for using rain water instead of tap water, which has slightly more nutrients.

Perhaps the most important factor in the growth of a plant is the type of bud which is encouraged to grow. The apical bud of a branch is usually the most vigorous, and grows most rapidly. When a branch is cut, the highest buds on the stump will start to grow, and again, the larger the bud, the faster its growth. Therefore one can greatly reduce the growth of a plant by pruning off all the larger buds. Since an upright shoot grows fastest, it is possible to reduce its growth bringing it in a horizontal position, or even by bending it downward.

Finally, by keeping plants under somewhat unfavorable conditions, one can also reduce growth. This is probably one of the reasons why they develop most typically in a shaded position, and not in a greenhouse, in which they might start to grow too fast.

The final recommendation by Mrs. Pipe seems to me to be a very wise one. As I explained earlier, a good bonsai tree, which is growing very slowly, is always close to death. Therefore one cannot become a good bonsai grower without occasionally overstepping the limits of deprivation; in that way one learns how far one can go. Therefore, each dead bonsai tree is a useful, be it a sad, lesson.

FRITS W. WENT

LITTLE BULBS, THE HARBINGERS OF SPRING

PAUL A. KOHL

IT IS remarkable how quickly the early bulbous plants respond to a few warm days at the end of winter. The little bulbs, tucked away beneath ground cover plants or snow, are ready to flaunt their colors at the first breath of Spring. They are the early messengers of the colorful season which follows. Just as the glacier lilies of the mountains burst into bloom along the

receding snow line, the snowdrops are the first of the little bulbs to bloom. They are well named because in some years they are trapped, but unharmed while in flower, by a late snow. Picture records kept over a period of years indicate that although snowdrops may bloom in early February they usually make their appearance in March. They never miss a season if left undisturbed and colonies grow bigger by the increase of bulbs and by seedlings which spring up around the original plants. Ground covers of euonymus, ivy or vinca are ideal companion plants for snowdrops.

Three little blue-flowered plants closely follow the snowdrops in late March. *Scilla sibirica*, the Siberian squill, bears charming bright blue flowers on three-to four-inch stalks. The flowers of Glory-of-the-Snow, *Chionodoxa lucilliae*, are of the same shade of blue but with a central zone of white. The third member of this blue trio is *Puschkinia libanotica*, the Lebanon squill. The flowers are a soft blue with a darker stripe down the center of each petal. All of these striking blue flowers may be planted in the perennial border, the rock garden or naturalized in drifts.

What can be more striking in early April than masses of large Dutch crocuses? One may select blue, purple, striped, white or yellow varieties or may mix them. If crocuses are not disturbed, they bloom for a number of years but are not as long lasting as the snowdrops and squills. Each year crocuses produce new corms above the old ones, like gladioli, and for that reason they gradually work their way to the surface and disappear.

Spring snowflakes, *Leucojum vernum*, resemble snowdrops but are taller and bloom in late April, thus extending the blooming period into the narcissus, hyacinth, tulip period. Bulbs planted three to four inches deep in a part of the garden where they can be left undisturbed will bloom each spring for many years without any further attention.

Beautiful clusters of blue flowers of grape hyacinths, *Muscari sp.*, appear in late April and May and bloom for a long time. These also are bulbous

White Crocus Kathleen Parlow

PHOTO BY P.A.K.

Wood Hyacinth *Scilla campanulata*

PHOTO BY P.A.K.

plants which will bloom each spring in the same location for many years.

In late April and early May we can again have scillas in the garden but this time they are the taller varieties of *Scilla campanulata* and related species. They are variously known as wood hyacinths, English and Spanish bluebells. Here we have a little trouble with plant names. Bulb catalogs list only *Scilla campanulata* as the wood hyacinth but botanical manuals, encyclopedias and garden dictionaries show *Scilla campanulata* as a synonym of *Scilla hispanica,* the Spanish bluebell. Wood hyacinths, as they are listed in catalogs, are excellent bulbs which can be naturalized and left alone for many years. Where one bulb is planted there will be a dozen or more in a few years and seedlings will spring up about the mother plants. A clump of wood hyacinths lifted in June, before the leaves disappear, will yield many round, white bulbs. These may be planted immediately or stored in a cool place and planted in the fall.

Spring-blooming bulbs are planted from October to December. Why not try some of them as they are such charming little fellows? True, they are not as spectacular as the daffodils and tulips but they have their place in the garden to usher in the spring season. They are so easy to plant, just about three inches deep in good soil and they make their growth before the trees leaf out so are not hindered by shade. There is a wide choice of varieties and colors from which to make selections in the various groups. There also are other early-blooming plants which may be planted with these bulbs. Varieties of *Iris reticulata,* species tulip, winter aconites and anemones are some of these.

Snowdrop *Galanthus nivalis*

PHOTO BY P.A.K.

Grape Hyacinth *Muscari botryoides*

PHOTO BY P.A.K.

PITZMAN NATURE PROGRAM

The fourth summer of the Pitzman Nature Program again brought to the Garden a large number of children between the ages of 7 and 17, both from the surrounding neighborhood and from as far away as Imperial, Missouri. Approximately half of the 550 children registered for the two sessions received certificates of achievement showing that they had attended the required number of class meetings.

As in the past, four courses were offered in each of the two five-week sessions. Members of the St. Louis Audubon Society gave instruction in the class on Birds, while the other courses—Trailfinders, Plants and Man and Man's Enemies—were conducted by Kenneth Peck and two Washington University students, Pat McCue and Brian Gordon. Don Mandell joined the teaching staff for the second session. A large contribution to the success of the program was made by the Assistants' Council, a group of young people who have attended past Pitzman Nature Programs. These young people displayed amazing vigor in running errands, making preparations, in assisting children in the Trailfinders class with their problems in making leaf prints, and in getting the ink off of their hands and faces.

The classes were held each Tuesday and Thursday morning and afternoon, with a supervised lunch hour. On intervening days, selected students came in to work on special projects under the direction of the staff. Research Teams in both sessions were engaged in the following activities:

Photography.—Habits of Plant Growth was the subject. Students also developed their film and prints.

Art and Observation.—Tree profiles of well known trees were drawn. Dissections and drawings of large pickled grasshoppers were made. With the aid of a microscope, the complete life cycle of a fern was followed and drawn. Another group sketched algae from the lake in the North American tract. A glass ant house was built and ants collected to inhabit it.

Photobiology.—Two classical experiments were repeated. One demonstrated effects of different colored lights on seed germination. The other showed the phototropism exhibited by rye coleoptiles.

Herbarium Work.—Students learned how to collect, press, and mount plants. Plants collected were added to a new reference herbarium.

For some of the students it was the second, third, or even the fourth summer of participation in the Pitzman Program. The continuing interest in the program, as well as the increasing enrollment, are welcome indications that today's youngsters are still interested in the natural sciences and are willing to spend part of their summer days learning instead of passing their time aimlessly.

BRIAN GORDON

SYMPOSIUM ON SYSTEMATICS

THE Eighth Annual Symposium on Systematics will be held at the Missouri Botanical Garden on Friday and Saturday, October 20 and 21. The subject of this year's Symposium will be "The Population Concept in Systematics."

The classification of both animals and plants was, for many years, essentially the classification of museum specimens. Modern systematics, however, considers organisms as populations occurring in nature, and treats museum specimens only as samples of these natural populations. The 1961 Symposium will consider the effects of this change in viewpoint on plant and animal systematics.

The Symposium will be led by Dr. W. Frank Blair, University of Texas, and Dr. Richard W. Pohl, Iowa State University. Five invited papers will be given on different aspects of the problem as it relates to botanical and zoological systematics. The Symposium is supported by a grant from the National Science Foundation.

BOOK REVIEW

The Japanese Art of Miniature Trees and Landscapes, their Creation, Care and Enjoyment. Yuji Yoshimura and Giovanna M. Halford. Charles E. Tuttle Co., Rutland, Vermont, and Tokyo, Japan. First edition 1957, 2nd printing 1959. 220 pp. 245 plates, 25 color plates, 42 text figures.

IF THE appearance of this beautiful book does little to increase the numbers of bonsai produced and cared for in the United States it will not be the fault of the authors or the publishers. It is authoritatively written and lavishly illustrated with photographs and detailed diagrams. The senior author is the son of a bonsai conoisseur. He has a bonsai nursery in the outskirts of Tokyo and conducts classes in that exacting art. Mrs. Halford, the wife of an Englishman stationed in Japan, studied with him for two years and has written the detailed directions and discussion in a clear, direct English prose. No secrets are withheld and no mystery is made of the methods by which the dwarfing is achieved.

Some of the dwarf trees are created from naturally dwarfed specimens, carefully dug up in the mountains, transplanted to an outdoor nursery and within a year or two adapted to life as potted plants. Others start as cuttings, layerings, grafts or seedlings, though the latter naturally take much longer to produce. All of them are given daily care year after year. Few indeed will be those westerners who have the patience and the skill for this art.

In appendices at the end of the volume are: (1) descriptions of tools and equipment; (2) soil analyses; (3) detailed specifications of the individual preferences of 340 different species grown as bonzai; (4) a plant index by

English and scientific names; (5) a plant index by Chinese-Japanese characters, as well as a general index.

EDGAR ANDERSON

This book is available in the Garden Information Center, Main Gate, price $7.50.

We also have *Bonsai Miniature Trees* by Claude Chidamian, D. Van Nostrand Co., price $3.95; and *Handbook on Dwarfed Potted Trees, The Bonsai of Japan*, Brooklyn Botanic Garden, price $1.00.

MISSOURI BOTANICAL GARDEN PROGRAMS

SPECIAL SHOWS AND DISPLAYS, Budgerigar Show, October 7 and 8

FREE NATURE PROGRAMS FOR CHILDREN, aged seven and over, are held every Saturday morning from 10:00 to 11:30 A. M. Meet in the Museum Building.

October 7 Fall's Carnival
14 Fall's Frolic
21 Planting Bulbs
28 Witches' Brew

COURSES FOR ADULTS BEGINNING IN OCTOBER

107 BULBS, INDOOR-OUTDOOR—2 sessions—Fee $8.00
Tuesdays, October 3 and 10—8:00 to 9:30 P. M.
Thursdays, October 5 and 12—1:00 to 2:30 P. M.

Instruction in bulb forcing and outdoor bulb culture will be given. The Garden will supply each student with 24 top quality bulbs in 7-inch clay pans which may be taken home. The Garden will also supply cool treatment which the forced bulbs require.

207 MOSSES AND FERNS—5 sessions—Fee $10.00
Wednesday, October 4, 11, 18, 25 and November 1—8:00 to 9:30 P. M.

General instruction in mosses and ferns. Participants will learn how to identify and to recognize the common kinds. Two sessions will be field trips to be arranged in consultation with the class.

108 HOUSE PLANTS—3 sessions—Fee $6.00
Thursdays, October 5, 19 and 26—8:00 to 9:30 P. M.

General instructions in kinds of house plants, care and growing requirements such as heat, light, water and fertilizer will be discussed. Special attention will be given to individual home problems.

105 HOW TO PROPAGATE FROM CUTTTINGS—5 sessions—Fee $12.00
Tuesdays, October 17 to November 14—8:00 to 9:30 P. M.
Thursdays, October 19 to November 16—1:00 to 2:30 P. M.

Fundamental facts and procedures of producing trees, shrubs and perennials from cuttings (asexual reproduction). The Garden will supply one plastic covered metal flat, media and plant materials for 40 to 50 kinds of plants.

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SOME FACTS ABOUT SHAW'S GARDEN

The Missouri Botanical (Shaw's) Garden was established in 1859 by Henry Shaw, a St. Louis businessman, to be controlled by a Board of Trustees for the public benefit. The Garden is a non-profit institution which receives no support from the city or state, depending on the income from the Shaw estate supplemented by contributions from the public.

The old stone walls and cast-iron fences, the Linnean House, the Museum Building, the part of the Administration Building which was Shaw's Town House, relocated in the Garden in 1890, and the Tower Grove House, his country home, all date from Mr. Shaw's time. The Main Gate, display and growing greenhouses and most other facilities date from the period immediately following the turn of the century. The Climatron, opened in 1960, is the first of several new buildings planned for the Garden's redevelopment. It is the world's first geodesic dome, fully climate-controlled greenhouse and contains the Garden's tropical collections.

The Garden—70 acres—is open every day of the year from 9:00 A. M. until sundown; the greenhouses 9:00 A. M. to 5:00 P. M.; the Climatron Monday through Thursday 9:00 A. M. to 6:00 P. M., Friday through Sunday 9:00 A. M. to 10:00 P. M. (April through October); Tower Grove House is open daily from 10:00 A. M. to 4:00 P. M. (December to March on weekends only). The Display House presents four seasonal displays: November, Chrysanthemums; December, Poinsettias; February, Orchids; Spring, Lilies and other flowers. During the year are other shows, competitions and festivals sponsored by various Garden Clubs and Flower Societies.

Courses in Botany and Horticulture for adults are conducted by the Garden staff. Children's nature studies are provided each Saturday of the year and a special nature program is held during the summer. Information on these activities is published in the BULLETIN or may be had by mail or phone. The Garden maintains a research program through the Henry Shaw School of Botany, Washington University.

In 1926 an Arboretum — 1600 acres — was established at Gray Summit, Missouri. Foot trails and roads pass through the Arboretum and are open to visitors in April and May.

The Garden Administration Building is located at 2315 Tower Grove Ave., and the Garden main entrance is at Tower Grove and Flora Place. The entrance at Tower Grove and Cleveland Avenue is also open to the public. The Garden is served by both the Sarah (No. 42) and the Park-Southampton (No. 80) city bus lines.

Persons interested in helping to support the Garden and taking part in Garden activities are urged to do so through the "Friends of the Garden". Information may be obtained from the Main Gate or by mail or phone.

MISSOURI BOTANICAL GARDEN

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COVER: *Epidendrum diforme* being visited by the moth **Amastas acona.**

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Marine Studies on Cape Cod, illustrated lecture on work done at the Marine Biological Laboratory, Woods Hole, Massachusetts. By Michael Wynne and William Rayburn. Monday, November 6th, 8:00 P. M., in the Museum Building.

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NATURAL POLLINATION OF ORCHIDS

C. H. DODSON AND G. P. FRYMIRE

THE pollination process of many plants is intensely interesting and none more so than in the case of orchids. One of Charles Darwin's most fascinating books dealt with pollination mechanisms in the orchids but unfortunately he was severely limited by a paucity of accurate information about pollination in tropical orchids. His comments were based upon deductions made from plants grown in the greenhouses of England and he had no opportunity to confirm them in the field. His work on the native orchids of Europe was based on actual observation and is excellent.

Paul Allen's works on the pollination of *Coryanthes*, *Gongora* and *Cycnoches* have been the only accurate observations of orchid pollination in the tropics of the western hemisphere since the time of Darwin. Unfortunately, due to pressure of other duties, Allen was unable to continue with this interesting subject.

We present here observations made in Ecuador on a number of tropical orchids which should give the reader an insight into the relationships between the flower and its pollinator. In most plants there is a high degree of dependency of one upon the other; however, in many of the highly evolved orchids it seems as if the orchid often takes complete advantage of the insect. The insect is not necessarily given reward in repayment for his visit and he is often trapped, flung about, burdened with heavy weights and even drugged as a consequence of his inquisitiveness. Such behavior on the part of the orchid has apparently come about as a response to an intrinsic need for maintenance of cross-pollination among its own kind while on the other hand barriers which discourage hybridization with other species are erected.

These observations point up the fact that much of the work of biologists is still to be performed out in the forests, deserts, mountains and lakes, in fact, anywhere in the open air. We are too often prone to think of the biologist in a white coat in a laboratory engrossed in study of a rack of test tubes or long-dead plant or animal specimens. There is yet, and will be for many centuries to come, a great deal of work to be done in direct contact with living organisms in their natural environment in an attempt to piece together the various and curious interrelationships of life.

In 1960, we initiated a series of

The Latin names of plants and insects are printed in the indicated type to assist the reader to quickly recognize them.

Orchid family—*Italics type*.
All other plant families—SMALL CAPITALS.
Insects (mostly bees)—**Bold face type**.

studies of pollination in tropical orchids in Ecuador and the following brief résumé of our field notes indicates the considerable success encountered. The photographs which accompany this article were, for the most part, made in the field. In some cases the original photographs were not satisfactory for reproduction and at a later time the same bees were reposed exactly as in the original photograph. Notation has been made in the subtitle of each picture which was reposed.

Observations

Our first observations of orchid pollination were made in December of 1959 on *Catasetum macroglossum* growing abundantly in the semi-arid regions on the coastal plain of Ecuador. These observations were particularly fascinating since we had read Darwin's account of the strange pollination mechanisms to be encountered here in the genus and were anxious to know whether his comments, which were made primarily on the basis of greenhouse studies supplemented by superficial observations by Dr. Cruger in Trinidad, were really valid. We did find the major portion dealing with the ability of these strange male flowers to fling pollinia onto the back of the unsuspecting bee, to be accurate. Surprisingly enough, the story goes far beyond Darwin's imagination. If Darwin had had the opportunity to actually see the flowers being visited by male bees only, to see the bees become intoxicated and fight among themselves for the right to enter a given flower, and to realize that the bees were not visiting the flowers for nectar or to gnaw the fleshy material inside but come as if drawn to the musky scent of the flowers to be drugged, he would surely have been even more impressed with the wonders of nature.

The male bee, **Eulaema cingulata**, hovering in front of a female flower of *Catasetum macroglossum*.

The first plant that we encountered with the bees actually visiting the flowers had female flowers (Fig. 4). The female flowers have a hood-shaped lip and the bees, attracted by the odor, would hover in front of the flowers for a few seconds and then land and crawl inside. We observed the bees scratching the inner surface of the flowers with the claws of their front tarsi,* "much as a dog digging a hole." After about 45 seconds of this behavior they would back out of the flower, hover in the air a few inches away from the flower and then repeat the process. Gradually the bees would become less wary and seemed to become intoxicated. Several bees were

*See glossary at the end of this paper for the meaning of such terms as tarsi, pollinia, metathorax, etc.

collected and forwarded to the Smithsonian Institution where they were determined by Dr. Carl Krombein as males of **Eulaema cingulata** and **E. tropica.** We also captured a female of similar morphology but of larger size and different coloration which we had seen entering a hollow limb of a large tree along a stream bed. This bee was determined as **E. dimidiata.** We observed several similar bees visiting flowers of PRESTONIA SP., a small flowered species of vine belonging to the Apocynaceae. This species of bee, however, was not attracted to the *Catasetum.*

Our next encounter with these bees was on Monticristi near Manta in the province of Manabi, on the 15th of January of 1960. The bees were observed visiting PRESTONIA MOLLIS and THEVETIA PERUVIANA, both of which are members of the Apocynaceae and are common in this region of dry desert. We did not actually see these bees accomplishing any pollination, but highly suspected them of pollinating *Trichocentrum tigrinum* var. *splendens,* an assumption which was later corroborated at the Instituto Botanico of the University of Guayaquil. Also working the Apocynaceous flowers were considerable numbers of **Eulaema tropica** and we captured one bee tentatively identified as **E. bomboides.** While on the hillside we noted that a high percentage of the flowers of *Oncidium hyphaematicum* were pollinated, and first suspected the **Eulaemas** of being the pollinators but though we placed flowers of PRESTONIA alongside the flowers of the *Oncidium* and the bees visited the PRESTONIA, they were not interested in the flowers of the fragrant *Oncidium.*

We did, however, observe a strange behavior pattern of a bee of the genus **Centris.** This bee (later found to be a male), about the same size as a worker honey bee, would sit on a stick near an erect inflorescence of the *Oncidium* and would drive away any other bee that passed nearby. Occasionally this bee would fly out and hover in front of the inflorescence of the *Oncidium* and when the wind moved the inflorescence the bee would dart in and strike a flower. The bees of this genus are extremely rapid fliers. Investigation showed the flowers to be freshly pollinated after the bee had

Male flowers of *Catasetum macroglossum* with three species of **Eulaema, E. cingulata, E. tropica** and **E. bomboides,** visiting. (posed)

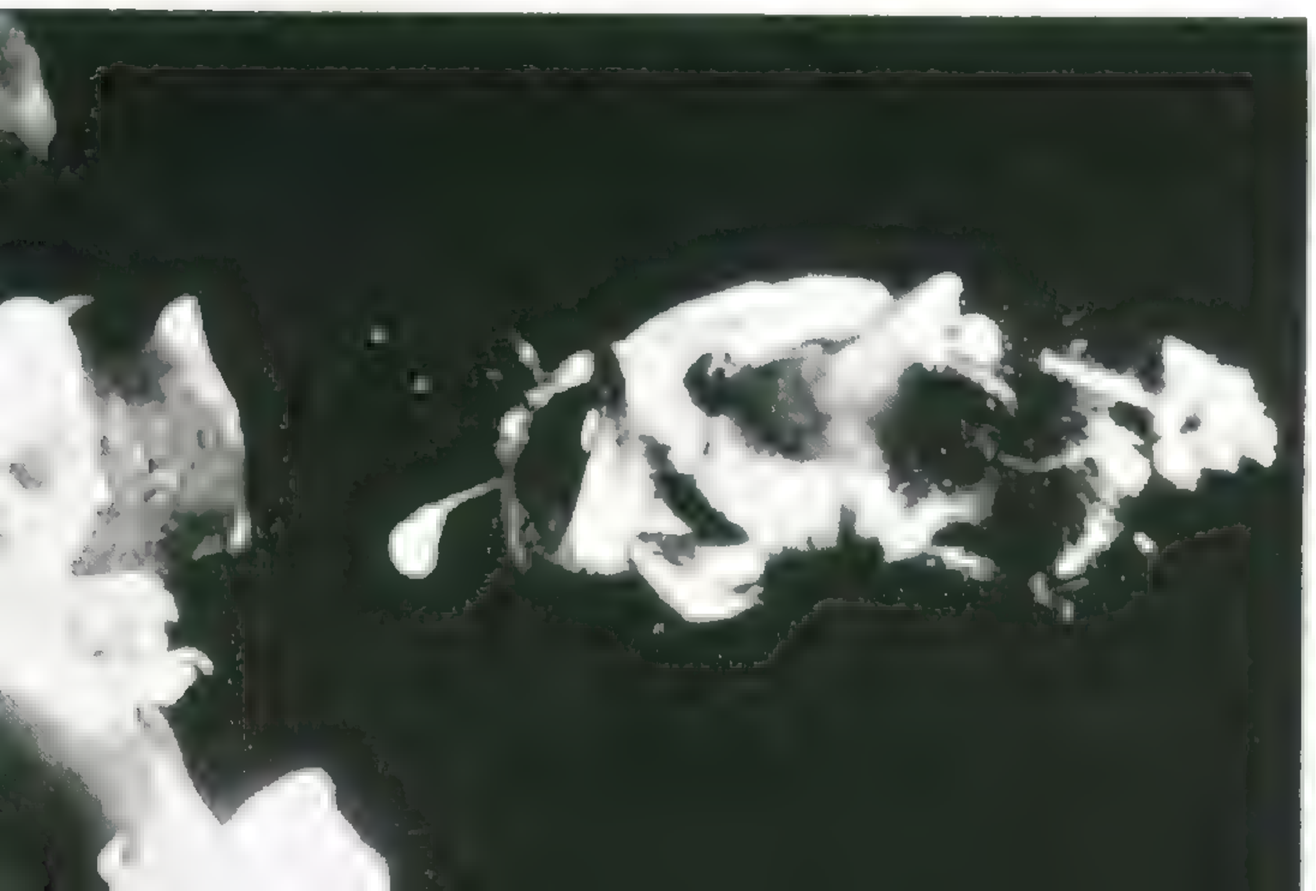
struck them. After we removed the flower spike the bee left but we discovered him shortly thereafter near another spike of *Oncidium* flowers continuing the same behavior. Near this *Oncidium* inflorescence was an inflorescence of PRESTONIA MOLLIS which was regularly visited by **Eulaema.** The bee was extremely busy chasing other bees and we later captured him by employing a "double envelopment" by simultaneously swinging our insect nets from opposite directions.

From here we moved to Quevedo and found a plant of *Stanhopea tricornis* in the cacao trees nearby. We took it to town overnight for safekeeping. The buds opened on it the following morning. We took it back out to the cacao orchard, gathered several specimens of the various species of orchids in flower in the area and made a "set-up." By concentrating a number of orchids in flower in one locale we felt that the possibility for attraction of the pollinator would be enhanced. At about 9 A. M. two male bees of **Eulaema dimidiata** visited the flowers and were photographed. The bees searched for some time to find the entrance to the flowers but finally got in and upon leaving picked up the pollinia on their dorsal metathorax. Nests of what later proved to be **Euplusia smaragdina** were observed on the ceiling of a store along the road.

Our next trip was to Bucay, on the railroad from Guayaquil to Quito. During the first few days of February it rained regularly. Along the railroad near the edge of town a plant of *Epidendrum difforme* was found growing on a fence post. The flowers were examined and the pollinia matched perfectly those found on a moth, **Amastus acona,** on the road from Duran to Tambo during the previous week. The length of the nectary of the flower matched perfectly the location of the pollinia on the proboscis of the moth. We found only one other *Epidendrum* which was in flower in this region, and its pollinia were very different from those of *Epidendrum difforme.* In the morning we took the train down to La Lolita, west of Bucay, at 350 meters elevation, to observe nests of **Euplusia smaragdina** which we had noted in the walls of the railroad station. We arrived

Male bee of the genus **Centris**, hovering in front of the flower of *Oncidium hyphaematicum*, with pollinia attached to its head from a previous flower. (posed)

The bee striking the flower and leaving pollinia in the stigma. (posed)



Drawing showing the steps by which pollination occurs in *Stanhopea tricornis*

before dawn, in the rain, and observed the bees leaving the nests at the first sign of light. The bees came and went, for the rest of the day, carrying food and bark for nest construction. One female bee was captured with pollinia of *Sobralia violacea* on her dorsal thorax. No male bees were observed in the area. The nests consisted of numerous cells constructed of bark held together with liquid which we believe to be sap which the bees were observed collecting from SPONDIAS MOMBIN (Anacardiaceae). The cells make up tubes up to 15 cm. long and 1 cm. in diameter. Each tube is a series of cells constructed parallel, when space is available. As soon as it is long enough, a sweet sugar-like material is placed inside to a depth of about 8 mm., an egg is laid and the cell is sealed off leaving a cavity about 2.5 cm. long. Work continues extending the same cell. Apparently only one female works on each tube but other females often build a tube alongside, forming a colony. Perhaps 20 females were working at this site. In one of the termite-eaten beams inside the building we found nests of **Euglossa viridissima** and several female bees of this species were collected while coming to the nest. They had a base color of metallic green but varied considerably in color, some having a golden or bronze cast. Several male bees were captured outside of the building where they were hovering

around some of the plants. Also collected here were several kinds of small and large carpenter bees working in the beams, as well as some small **Centris** which had nests in small holes.

The following day we caught the train up to Olimpo, elev. 900 meters. In back of the station are some thorn forests near the small branch of the river Chanchan. Many plants of *Catasetum macroglossum* occur here and **Eulaema tropica, E. bomboides, E. cingulata** and **E. speciosa** were captured working the *Catasetum*. Some of the bees had as many as three pollinaria of *Catasetum* attached to their dorsal thorax. Some had pollinia of *Sobralia violacea* and in one case, first *Catasetum* then *Sobralia* and then *Catasetum* pollinaria were superimposed. The bees enter the male *Catasetum* flowers in the same manner as the female flowers but encounter the antennae of the male flowers which, when touched, cause the viscid disk of the pollinarium to be flung upward and strike the dorsal thorax of the bee, immediately becoming cemented into place. The male bees reacted in the same manner as in the first observation and fought with each other for the opportunity to enter the flowers.

Also growing here are *Lycaste xytriophora*, which we observed being visited by **Euglossa viridissima,** and *Stanhopea bucephalus*, which was visited by **Eulaema bomboides.** The *Lycaste* is pollinated in rather a simple manner, the bee entering the rather large flower by landing on the outstretched lip and having the pollinarium stuck to the underside of the dorsal projection of the metathorax when he backs out. In repeating the process at another flower the bee leaves the pollinia in the stigma upon backing out. Pollination of the *Stanhopea* is much more complex. In this species the bees fly into the space between the lip and the column and, being unable to hold on to the slippery surfaces, fall down and through the flower, picking up the pollinia on the underside of the dorsal projection of the metathorax on their way through. The flowers cannot be pollinated immediately thereafter due to the stigma being closed. The stigma does not open until the following day, thereby making cross-pollination nearly obligate.

Only in the case of the *Sobralia* is food, that can be ingested with the ligual processes of the bees, provided by the flower and in that case both male and female bees are attracted. In the other cases, i.e., *Catasetum*, *Lycaste* and the two *Stanhopeas*, no apparent food of any kind was available nor did the bees attempt to chew the fleshy parts of the flowers. This same pattern was found to hold through all of our observations.

Over a period of a year we had brought a considerable number of orchids in to the garden at the Instituto Botanico at Guayaquil and numerous bees of **Eulaema cingulata, E. tropica** and **Euplusia smaragdina** were present in the garden and did often visit these flowers. **Euglossa viridissima** was also present and visited and pollinated *Trichopilia rostrata*. This is a relatively simple flower as is *Lycaste xytriophora*. In this case, however, the pollinarium is attached to the frons of the bee rather than the

metathorax when the bee forces his way into the tubular flower. The stipe of the pollinarium depresses due to differential drying and when the bee enters the next flower, the pollinia are in such a position as to be forced into the stigma of the flower.

Males of **Euplusia** were observed visiting HIBISCUS flowers and were commonly found visiting THEVETIA PERUVIANA from January to May, but when the evenings became cool in mid-May the bees no longer came. Females of **E. smaragdina** were observed in abundance at THEVETIA but did not visit the HIBISCUS. Bees were marked in January and were observed until May indicating that both male and female bees are long-lived. **Eulaema tropica** visited two species of ANTHURIUM on several occasions. Males and females of **Euplusia smaragdina, Eulaema tropica** and **Xylocopa frontinalis** visited and pollinated *Sobralia violacea* in the garden.

We had brought the beam which contained the nests of **Euglossa viridissima** back to the Institute and a female bee which had apparently hatched from one of the cells was found trapped in a hybrid *Cattleya*. She had become tangled in the stigmatic area of the flower. The nests of the **Euglossas** are constructed of a waxy material which is soft at first but later takes on a hardness like shellac. The cells are individual and not necessarily joined together but the whole cavity containing the cells was coated with the same wax, indicating a community effort.

Euglossas were noted visiting THEVETIA PERUVIANA, IMPATIENS BALSAMINA and several members of the Bignoniaceae.

Males of **Euplusia smaragdina** were observed pollinating *Notylia wullschlaegeliana*, plants of which had been brought into the garden from Monticristi. The bee would land on the capitate cluster of small pink flowers, grasp a flower and thrust its head into the front of the flower thereby having the viscidium of the pollinia stuck to the frons of the bee. The stipe depresses and the pollinia are then deposited in the narrow stigma on the front of the column. The flowers can not normally be self-pollinated for the stigma does not open for several hours after the pollinia have been removed.

Two male specimens of **Euplusia smaragdina** were collected, which had pollinaria of an unidentified orchid on the trochanters and femurs of the second pair of legs. The viscidium was curved around the front side of the leg, the long slender stipe extended to the rear 3.5 mm. and then turned 180° for 4 mm., placing the pollinia in front and slightly below the leg. No orchid has been found to match these pollinia. We discovered a new genus of orchid allied to *Notylia* near Loja in southern Ecuador and the pollinarium of this orchid is very similar to that found on the bee. This might suggest that another species of this new genus of orchid will eventually be found in the region of Guayaquil. The bees were collected from THEVETIA PERUVIANA in April.

A short, half-day, trip was made in late March to La Toma, north of

Guayaquil on the road to Quevedo. Here numerous plants of *Oncidium pardothyrsus* were in flower and a small **Centris** was observed pollinating one of these plants following the same behavior pattern noted in the pollination of *O. hyphaematicum* by the **Centris** at Monticristi. The bee would hover in front of the flowers and the pendant racemes and when the wind moved them, would fly in and strike one of the flowers. The plant was collected and nearly all of the 20 flowers had been freshly pollinated. We kept the plant and later noted that all but one of the seed pods dropped off, indicating that the plants are self-incompatible and that only the first pollinia, brought by the bee from another plant, was effective in fertilization of the flower.

The next major trip was made in early April to Quevedo. Several species of orchids were in flower here and a number of flowering plants were collected and a "set-up" was made. Great quantities of *Aspasia epidendroides* were in flower and were observed being pollinated by males and females of **Eulaema cingulata** and **E. tropica.** This orchid has a long column which extends beyond the down-curved lip. It also has a relatively deep nectary contained in the space where the lip is adnate to the column. The lip is white and the rest of the flower is yellow-white with brown bars. The flowers have a strong clove oil odor. The bees hover in front of a particular flower and lower their long proboscis to a semi-forward projecting position before landing. Usually only one or two of the 6 or 8 flowers are ready at a given time and the bees apparently sense this by odor being stronger when the flowers are ripe. Upon landing, the proboscis is inserted into the nectar tube and the bee grasps the lip and hangs on. The bee's head is in position so that in drinking the nectar his frons touches the sticky viscidium and the pollinarium is carried away, cemented to his frons, when he leaves. The stipe depresses and upon visiting the next flower the pollinia are pushed into the sticky stigma and are pulled from the bee's head when he again leaves.

Plants of *Gongora maculata* were in flower in abundance and numerous male bees of **Euglossa viridissima** and a dark blue-purple species of **Euglossa** were observed pollinating them. The flowers have a strong musky odor suggestive of dead fish. Our observations corroborated those published by Paul Allen in that the bee lands on the inverted fleshy lip and once again scratches with the front tarsi on the inner portion of the hypochile. The bee does not stay in this position for long and in attempting to regain flight, falls downward, sliding on the curved surface of the column until it hits the protruding viscidium. The viscidium and rostellum slide under its thorax and the sticky viscidium is cemented in place. The same procedure pollinates the flower but only in flowers which are a day older and have the narrow stigmatic pocket open and receptive. The bees do not give up after the first few tries but persistently continue to work the inflorescence for hours. These plants are closely related to *Stanhopea* and in many of

Euglossa viridissima scratching the lip of *Gongora maculata*. (posed)

The bee sliding down the column and contacting the rostellum of the flower where the viscidium of the pollinarium is stuck under his metathorax. (posed)

these orchids the flowers last only a day or two after opening. This phenomenon is apparently caused by the flowers not opening until they are completely mature. In *Gongora* and *Stanhopea* most of the flowers on an inflorescence are open within a matter of a few minutes after the first flower opens. In most orchids the flowers open gradually and only a few flowers are completely mature at a given time. Many of these will ultimately have all of their flowers mature at the same time but often considerable time passes before this is so.

Cycnoches lehmannii was in flower in quantity during this season and only male **Eulaema cingulata** were observed to visit these flowers. The other species of **Eulaema** were present but did not visit this species even though other orchids which they did visit were in close proximity. The very strong odor emitted by this orchid is similar in many respects to that of *Catasetum macroglossum* but has subtle differences which are easily noted even by the human nose. Certainly the bees

differentiate without difficulty for though **E. cingulata** visits both orchids indiscriminately the other species of **Eulaema** are not attracted to *Cycnoches* as we demonstrated in the garden of the Instituto on numerous occasions. The bees fly to the male flowers of this species and land on the inverted lip, clutching the claw of the lip with the 2nd and 3rd pair of legs and scratching the surface of the lip just beyond the callus with the claws of the tarsi of the first pair of legs. As in *Catasetum* and many of the other orchids of the *Stanhopeinae* and *Catasetinae* the male bees of the **Euglossini** seem to take on an intoxicated behavior from scratching the lips of the flowers and sopping up the exuded liquid from the epidermal cells with chemo-receptive pads present on the tarsi of these bees. These pads do not occur on the tarsi of the female bees. The callus of the lip in the *Cycnoches* extends out so far that the bee must release its grip with its 3rd pair of legs and swing the abdomen down to reach the source of the odor with the 1st pair of legs. In doing so the abdomen touches the tip of the column of the flower and by only very slightly lifting the anther-cover on the tip of the column, releases the tension-bound stipe of the pollinarium which whips up carrying the sticky viscidium causing it to strike the bee on the terminal ventral surface of the abdomen. The viscidium is cemented tightly to the bee's body and the stipe is curled tightly. The anther cap remains over the pollinia for at least half an hour, the stipe gradually dries and straightens out leaving the pollinia extended straight out in back of the bee.

The bee then flies on and encounters the female flowers which in this species are rather similar in form to the male flowers but are larger and have a short fleshy column rather than a long slender column. The same procedure occurs again but in this case the apex of the column of the flower has 3 hooks spaced so that when the round pollinia pass between one pair of them there is not sufficient space for them to pass through and one pollen mass is pulled off. The stigma is just below the hooks and the pollinia are forced into the stigmatic juices.

The female flowers occur only on robust plants which have been in full sunlight during the growing season. Less robust plants and plants which have been in partial shade during the growing season normally produce only male flowers. About 25 male inflorescences are produced for each female in the population and the male flowers last only 3–5 days while the female flowers last from 6 weeks to 2 months.

The same pollination phenomena were reported by Paul Allen in *Cycnoches ventricosum* in Costa Rica, in his revision of the genus. The same pollinator, **E. cingulata,** was reported for this Central American species also.

A species of MARANTA (Marantaceae) with heads of yellow flowers was abundant in this region and the bees were observed visiting these flowers to secure food. The bees would hover in front of the flowers, lower the tongue and insert it into the tubular flower in the same act as landing. Both males and females of **Eulaema**

cingulata, E. tropica and **Euplusia smaragdina** were collected from these flowers. Also **Exaerete smaragdina,** a large parasitic bee, which is parasitic on the nests of **Euplusia smaragdina,** of a brilliant metallic green color, was captured from these flowers and both males and females were taken.

More plants of *Stanhopea tricornis* were found in flower and placed in the set-up. Once again they were visited by **Eulaema dimidiata** as mentioned previously. The other species of **Eulaema** showed no interest in this *Stanhopea.*

Two bees which were captured on *Gongora maculata* had foreign pollinaria on their backs. One of these pollinaria, on the metathorax of a male **Euglossa viridissima,** was later determined to be from a *Cyrtopodium,* probably *C. punctatum.* The other, on the abdomen of the same species of bee, was from some type of *Zygopetalum* ally, probably a *Chondrorycha* or *Pescatoria.*

Male bees of **E. tropica** visited *Pescatoria wallisii* in the set-up. These flowers are rather open and simple and the bee simply forces his way in between the lip and column and the pollinarium of the flower is deposited on the terminal extension of the metathorax. These flowers have a sickeningly sweet fragrance.

In the latter part of April a trip was made to Balzapamba in the Province of Bolivar on the road from Babahoyo to Guaranda. Balzapamba is at an elevation of 775 meters and is on the western slopes of the Andes in the cloud forest region. An enormous number of orchid species are to be found in this region. We collected several species and made a set-up. *Gongora maculata* was abundant and we collected a number of **Euglossa viridissima** and the blue-purple species of **Euglossa** working these flowers. The only species of **Eulaema** encountered here was **E. cingulata,** but we found a large nest of this species located in an embankment near the bank of the river. The embankment apparently consisted of an old stream bed containing loosely piled stones which were later covered by soil. This left numerous holes and spaces in which all manner of animals make their homes. Approximately 25 female bees were observed coming and going at the nest, entering by way of a small hole in the dirt covering the embankment. The bees were noted carrying nesting material on the tibias of the 3rd pair of legs. They also brought in a white material, carried in the same manner, apparently for use as food for the young developing bees in the cells. An excavation was made

Eulaema tropica visiting and pollinating *Pescatoria wallisii.*

by removing the stones so that the nest could be observed. It was located approximately one meter inside of the embankment and was about one foot in diameter. A large accumulation of cells were in the nest, most of them old and discarded. The cells are constructed side by side in a loose order, each cell being about an inch long and oval in outline; the cell is constructed of fecal matter and the lower one-third is filled with the sweet white material. Then an egg is laid and the top of the urn-like cell is sealed over with a thinner cap of the same fecal matter. Many of the cells were parasitized.

This nest was apparently rather old and quite large. Six definite stages in construction were evident, with the first consisting of some 10 nearly decomposed cells. The second of about 25 was less decomposed. The third was of about 75, the fourth of about 125. The fifth had about the same number of which most were unhatched. The sixth was in construction and had some 20 cells sealed and 5 still open. Some of the cells of the fifth stage were opened and found to contain female bees in various stages of development, some ready to hatch. The sixth was removed and taken back to the Instituto and was later sent to the Missouri Botanical Garden. The bees hatched and all proved to be male bees. They hatched in mid-August, making a total elapsed time from collection and construction to hatching of about 4 months. The bees hatched over a period of about one week.

While we were excavating, the bees continued to work the nest, not at all disturbed by our presence. When the nest was finally open, a lone female bee appeared to be guarding the nest. She would come to the front of the nest each time the cells were disturbed and would make a fierce buzzing noise for a few seconds and then would return to the back of the nest. She refused to be driven away until some of the cells were removed. She appeared to be a young bee without the duller color of the older, shopworn females. One bee which was captured from the nest had brown hair covering the thorax rather than the typical black of the other females.

One female was captured with the pollinia of *Maxillaria grandiflora* affixed to the terminal projection of the metathorax. *Maxillaria grandiflora* was found in flower further up the road at an elevation of 1400 meters. This orchid produces a quantity of globular cells in the basal cavity of the lip which are apparently eaten by the bees.

Female bee of **Eulaema cingulata** visiting and pollinating *Maxillaria grandiflora*. (posed)

The color of the flower is white with a yellow and red lip. The lip is concave and the side-lobes surround the column until the bee forces the lip open. The flower is fragrant with a musty-sweet odor.

Two strange beetles were found which were parasitizing the cells, apparently eating the sweet food that the bees were placing in the open cells. The beetles were in an immature stage, were completely without visible eyes and had a morphological form very similar to that of the **Eulaemas** in that they had similar antennae, head shape, legs and bodies. The legs even had spines similar to those on the inside of the tibia of the bees. These beetle parasites have been reported for other bees and apparently the female beetles lay their sticky eggs in such a way that they are carried to flowers by the bee, left there, and picked up on the bodies of other visiting bees who then carry them to their nests.

Further up the road east of Balzapamba at an elevation of 1300 meters a large population of *Bletia purpurea* is found along the road cuts. Several bees were observed pollinating these small pink flowers. Abundant nectar is produced by these flowers in the nectary at the base of the lip. **Euglossa viridissima** and two undetermined species of bees were captured while visiting these flowers. All had pollinia of this *Bletia* on their dorsal thorax. Further up the road at 1400 meters elevation, a new species of *Catasetum*, which has not yet been named, was observed being pollinated by **E. cingulata.** This *Catasetum* has a strong odor of clove oil, similar to

Eulaema cingulata visiting *Catasetum fragrans* and receiving the pollinia on the underside of the thorax. (posed)

that of *Aspasia epidendroides*. The plants grow as terrestrials on very steep slopes. The flowers of this species are quite different from most *Catasetums* in that the flowers are perfect and the fleshy, short column is adnate to the fleshy, concave lip. The flowers are considerably smaller than the average *Catasetum*. The bee does not actually enter the flower but rather lands on the surface of the flower with its thorax over the column and its head entering the cavity of the lip. The pollinarium in this species is organized very similarly to that of *Cycnoches* and requires only a slight movement of the anther cap to be discharged. Males of **Eulaema cingulata** pollinate this species and the

pollinaria are stuck to the ventral portion of the thorax either in front of or between the legs. The pollinia are extended more or less at right angles on the end of the stipe. The stigma is in a cavity with sloping sides, leaving a hole, broad in the center but narrow at the sides. When the bee lands on another flower the pollinia which are extended down from the bee's thorax are pushed into the sloping cavity and are compressed so as to enter the cavity. Once inside, the pollinia again separate and are trapped by the narrower margins of the cavity. When the bees pull away, the pollinia are pulled off and pollination is completed.

Along the road cuts in this area are abundant plants of *Epidendrum ibaguense*. These were observed being pollinated by a swallow-tailed skipper which landed on top of the cluster of flowers and inserted its long proboscis into each of the erect, non-resupinate flowers. The pollinia stick to the skipper's proboscis and are carried from one flower to another.

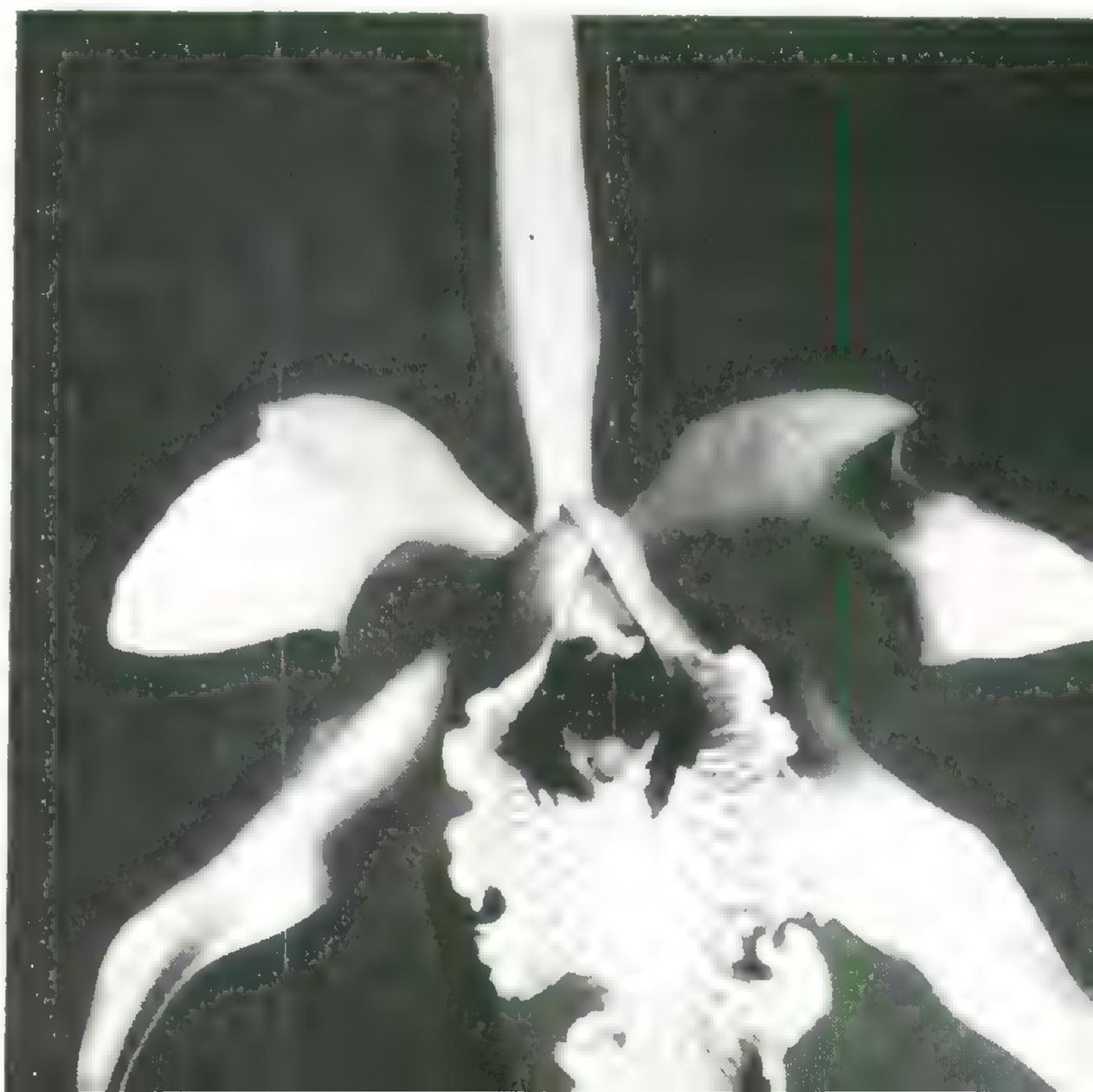
In passing through Babahoyo on our way home we noted that great quantities of nests of **Euplusia smaragdina** are stuck to the ceilings of the buildings where they are built over the sidewalks. Large clusters of cells were common.

Back at the Instituto Botanico a curious situation was observed. A large plant of *Oncidium onustum* which had been brought in and planted in a tree, produced 7 or 8 large inflorescences. For the first few weeks none of the flowers were pollinated, but one day it was noticed that some of the flowers had been visited and pollinated. This continued for several days in succession and finally a female bee of **Xylocopa frontinalis** was observed visiting these flowers. The bee was captured and had pollinaria of this *Oncidium* on its frons. After the capture of this bee, pollination of the flowers ceased for about 3 weeks and then once again commenced. Another **Xylocopa** of the same species and sex was captured.

It appears as though these bees can learn to visit such flowers. During this entire period considerable quantities of male and female **Xylocopa frontinalis** were present at all times in the garden visiting roses, ginger, HIBISCUS and *Sobralia* as well as various Legumes. Only the two bees ever learned to visit the *Oncidium*. They were apparently attracted by the odor for they did not pause for more than a moment on any given flower. The fragrance of the flowers is sweet with a tang of orange blossoms.

The month of May was spent in Guayaquil with a few short trips north of the city where a number of **Eu-**

Eulaema tropica visiting *Cattleya maxima*. (posed)



laema cingulata, E. tropica, E. dimidiata and **Euglossa viridissima** were collected while visiting PRESTONIA MOLLIS, several Legumes and Bignons. Also several **Centris** were collected, from a Malpighiaceous vine, which were quite similar to the bee which visited *Oncidium byphaematicum* on Monticristi. A week-end trip was made in early June to Manglaralto on the beach, north of Salinas. A large number of **Eulaema tropica** were collected from THEVETIA PERUVIANA. It was hoped that we would be able to confirm our prior observations at the Instituto Botanico that this species of bee pollinates *Cattleya maxima*, but the *Cattleya* was not in flower during this season. We had previously found pollinia of *C. maxima* on a flower of *Sobralia violacea* which had been visited by **E. tropica** in the garden at the Instituto.

In July, a trip was made to Loja in southern Ecuador and on over into the Amazon headwaters on the eastern side of the Andes. This region is one of the richest for orchid flora in the world. From the pass on the road from Loja to Zamora, at an elevation of 2800 meters the mountains decrease in altitude to 1000 meters at Zamora, a small town east of Loja. The climate is always cold and misty at the pass and becomes warmer gradually and more sunny warm days occur as the elevation decreases. The forested slopes maintain a great quantity of orchid species stratified according to their ecological needs. At Zamora a large number of **Eulaemas** were observed visiting the flowers of INGA SP. (Leguminosae) and a few **Eulaema cingulata** were collected from BIXA ORELLANA (Bixaceae). An extensive population of *Stanhopea wardii* occurs from km. 45 to many kms. below Zamora. The population is quite variable throughout but shows a cline from the upper end down to Zamora. From that point on out to Yansasa the cline is no longer evident and the variation appears to be at random. The presence of this cline from Zamora appears to be attributable to the fact that the pollinating **Eulaemas** apparently do not make their nests at elevations much higher than that of Zamora (1000 m.). These bees do range for long distances up the canyons during the occasional sunny warm days. The flowers of the *Stanhopeas* which occur at the higher elevations are much more fleshy and last considerably longer than do the flowers at the lower elevations. This may well be due to the need for a longer waiting period for pollination. The color seems to be correlated with fleshiness. The more fleshy flowers are much more yellow and the fleshiest are completely orange-yellow.

The pollinator of these *Stanhopea* flowers was not actually observed but it was suspected that it must be a species of **Eulaema** observed in abundance in this area. This species might be **E. niveofasciata,** very similar to **E. bomboides,** differing only in color. The abdomen in this species is barred with black and white stripes on the upper two-thirds and is copper-red for the lower one-third. Set-ups were made to attract these bees using female *Catasetum* flowers but none of them were attracted. Several **Eulaema**

cingulata did come however but did not demonstrate any interest in the *Stanhopea* flowers. We concluded from this that **E. cingulata** definitely does not pollinate *Stanhopea wardii* in this region and that, quite possibly, **E. niveofasciata** is the pollinator.

Elleanthus capitatus, representative of a genus closely allied to *Sobralia*, was flowering abundantly. The large plants with canes up to 6 feet long are pendant from large limbs of trees overhanging the river. The inflorescence is capitate and reminds one somewhat of a compound flower such as found in the Compositae. The purple flowers are small (¼ of an inch in diameter) and the buds are sunken in a mass of gelatin-like material. When the flowers are mature they protrude slightly from the gelatinous mass. These plants were also placed in a set-up but during many hours of observation nothing was seen to visit them. Later while traveling down the river by canoe, where we were passing under the trees regularly, we observed the flowers being visited by humming birds. The birds would spend several minutes hovering under each inflorescence, moving from flower to flower.

On the river trip to Yansasa, a tiny pueblo at 800 meters elevation, northeast of Zamora, along the Rio Zamora, pollination of *Cycnoches egertonianum* was observed. This species is representative of the heteromorphic group of *Cycnoches* in which the female flowers are morphologically very similar to those of the *Eucycnoches* group represented in Ecuador by *C. lehmannii*; however, they are somewhat smaller. The difference between the two groups of *Cycnoches* is dramatically demon-

Eulaema cingulata swinging free from lip of the male flower of *Cycnoches lehmanii*, touching and discharging the pollinia and receiving the pollinia on the apex of the abdomen.

The bee swinging free from the male flower of *Cycnoches lehmanii* just before depositing the pollinia in the stigma. (posed)

Euglossa viridissima landing on the flexible lip of the male flower of *Cycnoches egertonianum* and touching the anther cap which causes the pollinia to be thrown and be attached to the abdomen of the bee.

The same bee visiting the female flower and leaving the pollinia in the stigma.

strated by the male flowers of *Cycnoches egertonianum*. These flowers are much smaller than the others, are carried in long multiflowered, pendant spikes, and rather than having an entire blade to the lip, have a multipronged, divided blade. The claw of the lip in this species is flexible rather than being stiff and erect as in *C. lehmannii*.

Cycnoches egertonianum is pollinated by the small **Euglossa viridissima** males. *Cycnoches lehmannii* and *C. ventricosum* are pollinated by **Eulaema cingulata** as mentioned previously. The bees land on the pronged apex of the lip and the weight of the bee causes the claw of the lip to bend down, permitting the end of the abdomen of the bee to touch the anther cap on the tip of the elongated column. When the anther cap is disturbed, the pollinarium is released and flies up, the sticky viscidium striking and sticking to the bee's abdomen just as in the other species of *Cycnoches*. The pollination of the female flowers is precisely similar to the pollination of other species of *Cycnoches*. The column has the same three prongs which act to strip the pollinia from the abdomen of the bee as he falls past, attempting to orient himself after dropping away from the lip.

After our return to Guayaquil we made several trips to an area northwest of Guayaquil on the road to Salinas. These trips were only for a few hours each but a number of **Eulaema** were collected here. A stream comes down from the mountains above the Hacienda Cerro-Azul, forming a densely wooded arroyo. A few hundred yards above the cement plant the stream bed is about 10 yards wide, the walls rising rather abruptly. A few

large trees with rough scaly bark grow in the stream bed. These trees exude a white latex when damaged or wounded and the **Eulaema** come to these trees and drink the exuding sap.

A collection of 17 bees was made here. Two were male **Eulaema bomboides,** one was **E. cingulata** female. The rest consisted of an extremely variable population of **E. dimidiata.** Thirteen were males and one was female. The 13 males varied considerably in color but not in form. The color varied in several respects. The base color varied from metallic-green to blue-green to dark blue. The hair color varied from bees with bands of yellow and black to others which were yellow and black for the upper two-thirds of the abdomen and copper-red for the lower one-third; others were black with white bands and were copper-red for the lower one-third.

Conclusions

We have attempted for the most part to limit the above résumé to what we actually observed and to keep our evaluation of those observations to a minimum. This is not always possible and there is always a great deal of pressure to try to interpret those observations in relation to observations of other pollination phenomena reported by other investigators. The following then, is a brief summary of some of the observations in the light of what is known of such phenomena at the present time.

It appears as though we have been given the opportunity to lift the edge of the canvas covering the picture of the intricate mechanisms for their pollination which have been developed by certain of the advanced orchids. This peek at the picture left us with far more questions than answers. We saw only certain parts of the picture. Whole areas, which from the strange morphological characteristics of the flowers, promise to be fascinating, were not seen. A great many observations need to be accumulated before the rest of the picture will begin to become clear.

Certain of the observations present phenomena new to floral ecology—others tend to clarify and confirm previous reports such as the presence of flowers which attract only male bees.

The phenomenon of the **Centris** striking and thereby pollinating the *Oncidium* is new to floral ecology. There are two major possibilities for explanation of this behavior. Both involve the question of what the bee sees. First, it may be a case of pseudocopulation in which the bee sees the flower as a desirable female. This has been reported in other orchids but may not be applicable here. The bee strikes the flower and returns to its position hovering nearby so rapidly that the whole process can be missed in the blinking of an eye. The bee makes no attempt to land. Second, the behavior may be attributable to territorial protection. This has been reported for male **Bombus** in which the bee sits on a stick in the middle of a garden and drives away all other insects which enter the garden. The **Centris** appeared to be reacting in this way and industriously attacked any flying insect which passed through his territory. If this is true, then the bee must see the moving *Oncidium* flowers as flying

insects and strike them in an attempt to drive them away. The flowers are produced on long arching racemes which are swayed by the slightest breeze. This movement may appear to the bee as a flying insect. Or, the bee may see the flowers as something entirely different from what we see. It has been reported many times that bees see a different spectrum than do humans and particularly in the ultraviolet ranges. Perhaps the flower actually looks like another insect to an insect.

The importance of the observations of the pollination of the two types of *Cycnoches* lies in the discovery that the two groups of *Cycnoches* are not only morphologically different but are also ecologically different in the sense that different types of pollinators are required. The inference is, of course, that the reason the heteromorphic types of *Cycnoches* are distinct from the *Eucycnoches* group is centered on the evolution of a mechanical pollination system based on separate morphological characteristics of the pollinators available. The difference is apparently based on development of separate means of attraction of these two different types of insects. That the two types of insects are not really far separated in relationship to one another is certainly significant. The presence of a group of closely allied but morphologically distinct insects with slightly different behavior patterns, has permitted the evolution of a distinct group of plants.

There is considerable evidence that many of the remarkably unique orchids of the Western Hemisphere have had their development based on similar phenomena. Many of these orchids use male bees of the tribe **Euglossini**—either the genera **Eulaema, Euplusia** or **Euglossa**—as their pollinators. It seems that these bees are particularly susceptible to being attracted to flowers which do not provide food that the bee can use for sustenance. It is interesting to note that the female bees are not attracted to this type of flower. Perhaps the female bee cannot sense the presence of such flowers. One of the obvious differences between the male and female bees is the presence of chemoreceptive pads on the tarsi of the front pair of legs of the male bee. These pads may enable the male bee to sense the odors of these flowers. The reaction of the male bees to these flowers indicates that the senses of the bee are dulled and the bee becomes "intoxicated." In such a condition, the bee becomes susceptible to manipulation in unique manners to accomplish pollination.

No orchids with these types of floral mechanisms are to be found outside of the western hemisphere nor are the **Euglossini** encountered outside of the same area. It appears as though the orchids of these groups which "deceive and manipulate" the male bees have developed in this hemisphere in response to the presence of bees with a peculiar social organization, morphological characteristics and behavior patterns. For the most part, orchids which have distribution patterns which cover both hemispheres use insects which are present in both hemispheres as pollinators. In other instances, or-

chids which are limited to one hemisphere have counterparts in the other and are pollinated by similar insects. Many of the tropical American orchids such as true *Epidendrum*, *Spiranthes* and its allied genera, *Habenaria* and the Sarcanthine orchids, are probably pollinated by Lepidoptera in a similar manner to the Sarcanthine orchids and other Lepidoptera-pollinated orchids which form a major portion of the orchid flora of the eastern hemisphere. Another large group of orchids, the *Bulbophyllum* and its allies, in the eastern hemisphere are fly pollinated. It seems probable that many of the *Pleurothallids* in the western hemisphere form a parallel situation and are fly pollinated. The large, open-flowered orchids of the eastern hemisphere such as *Grammatophyllum*, *Cymbidium* and *Vanda* are pollinated for the most part by **Xylocopa.** These are rather simple in structure and compare quite well with orchids in the western hemisphere such as *Zygopetalum*, *Lycaste*, *Maxillaria* and their allies which appear to be pollinated by **Euglossini** instead of **Xylocopa.**

Another large class of orchids which either occur in both hemispheres or have similar counterparts in both hemispheres appear to be promiscuously pollinated by various kinds of bees. In the western hemisphere there are *Sobralia*, *Vanilla*, *Bletia* and possibly many of the lower *Epidendrinae*. In the eastern hemisphere similar orchids are *Phajus*, *Dendrobium*, *Bletilla*, *Coelogyne* and *Thunia*.

Pseudocopulation has been extensively reported in the genus *Ophrys* in Euroupe and in *Cryptostylus* in Australia. Though such phenomena have not been reported in the western hemisphere a number of orchids have characteristics which indicate that such will be reported in the future.

Glossary of Unfamiliar Terms Used in This Paper

Antenna; pl. **antennae.** A slender appendage on each side of the column of *Catasetum*; the "trigger" which sets off the pollen-throwing mechanism.

Column. The central portion of the orchid flower, which is formed by the partial or complete union of the male and female parts (stamens and style).

Femur. The third segment of an insect's leg (counting from the base), situated between the trochanter and the tibia.

Frons. The facial area of an insect's head.

Hypochile. The basal portion of the lip in *Stanhopea* and related genera.

Metathorax. The posterior division of an insect's thorax.

Pollinarium. The complete set of pollinia with associated parts—viscidium or viscidium and stipe.

Pollinium; pl. **pollinia.** In the orchids, a more or less compact mass of pollen.

Proboscis. An elongate but not rigid (often curled) feeding organ of certain insects, such as flies and butterflies, which is of the mouth parts.

Resupinate. Having the pedicel of the flower twisted so that the part of the flower which is uppermost in bud (the lip) is on the lower side when the flower matures.

Rostellum. A portion of the stigma which is specialized to take part in the pollen transfer from one flower to another; the tissue which separates the anther and the functional stigma.

Stipe. A non-viscid band or strap of columnar tissue which connects the pollinia to the viscidium, as in *Oncidium* and *Vanda*.

Tarsus. The fifth segment of an insect's leg.

Thorax. The portion of the body of an insect located between the head and the abdomen.

Tibia. The fourth segment of the leg, between the femur and tarsus, analogous to the shin bone.

Trochanter. The first segment of the leg of an insect, to which the femur is attached

Viscidium. A viscid part of the rostellum which is removed with the pollinia as a unit, and serves to attach the pollinia to an insect.

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SOME FACTS ABOUT SHAW'S GARDEN

The Missouri Botanical (Shaw's) Garden was established in 1859 by Henry Shaw, a St. Louis businessman, to be controlled by a Board of Trustees for the public benefit. The Garden is a non-profit institution which receives no support from the city or state, depending on the income from the Shaw estate supplemented by contributions from the public.

The old stone walls and cast-iron fences, the Linnean House, the Museum Building, the part of the Administration Building which was Shaw's Town House, relocated in the Garden in 1890, and the Tower Grove House, his country home, all date from Mr. Shaw's time. The Main Gate, display and growing greenhouses and most other facilities date from the period immediately following the turn of the century. The Climatron, opened in 1960, is the first of several new buildings planned for the Garden's redevelopment. It is the world's first geodesic dome, fully climate-controlled greenhouse and contains the Garden's tropical collections.

The Garden—70 acres—is open every day of the year from 9:00 A. M. until sundown; the greenhouses 9:00 A. M. to 5:00 P. M.; the Climatron Monday through Thursday 9:00 A. M. to 6:00 P. M., Friday through Sunday 9:00 A. M. to 10:00 P. M. (April through October); Tower Grove House is open daily from 12:00 M. to 4:00 P. M. (December to March on weekends only). The Display House presents four seasonal displays: November, Chrysanthemums; December, Poinsettias; February, Orchids; Spring, Lilies and other flowers. During the year are other shows, competitions and festivals sponsored by various Garden Clubs and Flower Societies.

Courses in Botany and Horticulture for adults are conducted by the Garden staff. Children's nature studies are provided each Saturday of the year and a special nature program is held during the summer. Information on these activities is published in the BULLETIN or may be had by mail or phone. The Garden maintains a research program through the Henry Shaw School of Botany, Washington University.

In 1926 an Arboretum — 1600 acres — was established at Gray Summit, Missouri. Foot trails and roads pass through the Arboretum and are open to visitors in April and May.

The Garden Administration Building is located at 2315 Tower Grove Ave., and the Garden main entrance is at Tower Grove and Flora Place. The entrance at Tower Grove and Cleveland Avenue is also open to the public. The Garden is served by both the Sarah (No. 42) and the Park-Southampton (No. 80) city bus lines.

Persons interested in helping to support the Garden and taking part in Garden activities are urged to do so through the "Friends of the Garden". Information may be obtained from the Main Gate or by mail or phone.

MISSOURI BOTANICAL GARDEN

Bulletin

December 1961
Volume XLIX
Number 10

The Friends of The Garden

Friends of the Garden

ANNUAL REPORT

AND

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REPORT OF THE PRESIDENT OF THE FRIENDS OF THE GARDEN

I would like to begin this report to Friends of the Garden with a personal expression of my appreciation to all of you who have worked so very hard and contributed so much during the past year. Whether you worked in the office, helped clip the rose garden or with the art activities or solicited new members, your efforts were rewarding for the Garden, as I hope they were for you personally.

Friends can best support the Garden by contributing their active services as well as their membership dues. Some, of course, will not have the time to do this. But when a word of explanation about the Missouri Botanical Garden can be spoken to someone who does not know about it or when a new Friend can be found, or children can be encouraged to attend the excellent summer and Saturday programs, then a personal involvement begins that proves most fruitful. Henry Shaw left a legacy rich in knowledge and pleasure, yet while the Garden may grow beautifully, its purpose will not be fulfilled if the people of St. Louis do not become involved with it.

It is most encouraging that the past few years have seen a tremendous resurgence of interest and atendance in Shaw's Garden. Last Spring a Friends' Executive Council was appointed and this group of interested and Garden-minded people has given the Friends' officers much benefit from their knowledge and support.

With this assistance from the Council, and the presence of Mrs. Kathleen Miller our capable Executive Secretary, the past year has been well organized and the most active on record. The Friends' office at the Main Gate, repainted and refurnished through the generosity of several friends, is running efficiently. Several days a week volunteers are at the office to help with mailings, files and other routine matters.

During the spring and summer more people became personally associated with Shaw's Garden through a series of new activities. A photography exhibit, a benefit jazz concert, painting and flower preserving classes, an art show in the Floral Display House, a concert of classical music by string players — all of these activities were well received and we hope will be repeated.

Friends' membership figures, totaled as of October, 1961, about 3250, making the organization the largest it has ever been. We need, however, to increase our numbers greatly and are actively planning to do so. Last spring a letter was sent to all Friends asking for volunteers to help recruit new members. Initial response was very good. This kind of endeavor is never ending and must be carried out on a

continuous basis to keep membership growing.

We were most encouraged by the generous response of several St. Louis businessmen who agreed to undertake an effort to secure corporate memberships in the Friends. The Committee is approaching business firms in the area for regular annual memberships, and at this writing (October) has received approximately $7,000 to help in the current operation of the Garden. Its goal is $25,000 annually, and anyone who would like to participate in this program is warmly invited to contact Harry Wuertenbaecher, Jr. Your help will be welcome.

During the fiscal year ending June, 1961, the Friends collected from membership dues and spontaneous donations $44,139, used entirely to support the Garden's activities. Mr. Smith and Dr. Went have elsewhere in these pages very graciously expressed their thanks for this support and I can add only that membership in the Friends is probably one of the best investments you can make!

Social activities have continued to center around the preview parties held several times each season at major flower exhibits. The members of the Women's Association continue to serve as our hostesses for these occasions and I want to express our gratitude to them.

The present issue of the *Bulletin* marks the first time a membership list has been formally published. We hope your name is there and spelled correctly! We hope most of all that through the years to come this list will grow and that more and more St. Louisans will support our great botanical garden.

I want to close this brief report by expressing our sincere thanks for the time, patience and cooperation contributed by Dr. Went and his talented staff, that have made our work so rewarding.

It is a very exciting thing to be a part of Shaw's Garden these days!

Mrs. William R. Bascom
President

REPORT OF THE DIRECTOR OF THE GARDEN

As Friends of the Garden, all of you have undoubtedly noticed the many improvements at Shaw's Garden during recent years. I want you to know how much you are contributing to this upgrading, and how much the staff and personnel of the Garden depend upon you to help continue this improvement.

We are looking forward to the time when Shaw's Garden will be the leading botanical garden in the world, where beauty, inspiration, information and investigation will be blended to a degree never before attained. When this point is reached, St. Louisans can be genuinely proud of their garden, for it was Henry Shaw who started the Garden, and it must now be a joint undertaking between his legacy and the people of this area.

About half of the Garden funds are derived from income of the endowment Shaw left, and the other half

is contributed by you, as a Friend of the Garden, by the hundreds of thousands of visitors who pay their modest entrance fee to the Climatron, and by the other auxiliary groups, such as the Women's Association, the Horticultural Council, the Historical Committee and other groups all of which support the Garden's work in so many helpful ways. Not a cent of tax money goes into the operation of Shaw's Garden; it is soley supported by those who really believe in it, and who are willing to make contributions to it in the form of money and work.

If you will continue your support, and can even increase it, the Trustees and the Director will be able to do their part. In this way Shaw's Garden may become the first botanical garden which can be operated solely on voluntary public support, through fees and contributions from the people who believe in the Garden and receive enjoyment and inspiration from it.

In the meantime, I hope that you feel that you are getting your full measure of enjoyment from your Friends' membership, not only by visiting the Garden frequently, but also by the realization that you help to provide a share of the enjoyment to the half million persons who visit the Garden each year, and who have not as yet joined as Friends.

FRITS W. WENT
Director

REPORT OF THE PRESIDENT OF THE BOARD OF TRUSTEES OF THE GARDEN

THIS is a pleasant way to greet all the Friends of the Garden. Particularly to those who have been members over the years do I extend my thanks, for your help has meant a great deal. To those who have recently become members I extend a hearty welcome and express the hope that you are finding your membership interesting and rewarding.

The growth in the membership figures of the Friends has been very encouraging. The continuing endeavors of those who have "been a Friend and brought a Friend" have speeded our efforts in rehabilitating the Garden.

It is just a little over a year since we dedicated the Climatron. This architectural and botanical achievement has brought the Garden nationwide publicity and recognition. We are confident this is just the beginning, for many projects are being pondered and planned. I want briefly to tell the Friends about them.

For a long while we have been dissatisfied with existing means of displaying the unique hybrid water lilies developed at Shaw's Garden over the past 30 years. New and modern ways are possible and should be implemented to give the lilies the environment they deserve, in harmony with the glowing backdrop of the Climatron.

An interested admirer of the Garden has suggested to us a sound reproduction system that can be installed to bring recorded or live music during certain hours to specific areas of the Garden and enhance its attraction as a retreat from the city's busy whirl.

We want to enlarge and improve facilities for the comfort and enjoyment by the public of refreshments and relaxing pasttimes, as well as the beautiful flowers and landscape of the Garden.

Also, we have not lost sight of the next stages which were presented in the original master plan — a research building, new entrance facilities and more greenhouses.

Important in my own thinking is our endeavor to keep the Garden, first, at the service of the community; and, second, to keep it at the peak of its powers to serve our scientific age. This is a time when the achievement of the unusual is a day-to-day commonplace and miracles are taken for granted. We have become so familiar with broken records — in speed, in distance, in human endurance, even in the power to annihilate — that we tend to become indifferent to the highest achievements of the mind of man. Yet I feel deeply that we should cling firmly to the knowledge and intellectual environments that have made these achievements possible. Shaw's Garden is a prime example.

Here we have stored a broad history of plant life — in books, papers and specimen collections, much of it lost to the memory of man except for what is preserved here. It is important that this material be put in a form that will make it readily available to students and researchers, because often man can build the future only from what he has learned of the past. The experiments in progress at the Garden, with new greenhouses to provide suitable growing conditions, could serve at least a two-fold purpose: they could further scientific progress in the botanical field through the development of new and stronger species of plant life; and, if displayed to public view in the proper manner, they could stimulate students, particularly those of the younger generations, whose interest and imaginations could be aroused by the projects. The Garden must be kept at the forefront in the effort to solve past mysteries and in the struggle toward ever finer attainments in the world of science.

Added all together, these various plans and projects make an impressive program indeed. But our funds are being stretched to capacity just to meet increasing operating costs. If we are to move ahead we must have funds over and above those we depend upon for the regular budget. We believe that as the Garden grows the community's interest in it will grow. This has been proven by the greatly increased attendance during the past year, due largely to the attraction of the Climatron. With your help we can continue to formulate and consummate the master plan for the Garden's development, and prove to ourselves, and to those who come after us that we merit the confidence Henry Shaw believed he could place in coming generations. If we do, St. Louis will have a botanical center unsurpassed anywhere in the world.

I hope that every Friend of the Garden will take personal satisfaction in each forward step we take, as we lean heavily on your loyalty and cooperation that will help us attain these goals.

ROBERT BROOKINGS SMITH
President, Board of Trustees

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A highlight of 1961 was the award of the $25,000 R. S. Reynolds Memorial Award to architects Murphy and Mackey and the Missouri Botanical Garden for the Climatron. The brilliantly successful aluminum and Plexiglas dome is the first American structure so honored. Here, Dr. Frits W. Went receives a handsome aluminum plaque commemorating the event from Mr. R. S. Reynolds, Jr., president of Reynolds Metals Company, at the American Institute of Architects awards luncheon in Philadelphia in April.

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Memberships

Friends of the Garden is a non-profit membership organization concerned with the support and promotion of the Missouri Botanical Garden. It maintains an office at 2315 Tower Grove Avenue, St. Louis 10, Missouri. Memberships are available in the following categories:

Annual	$ 10.00	Sponsoring	250.00
Participating	25.00		
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Membership may be held jointly by husband and wife.

A membership runs one year from the date of its initiation. A membership will be considered delinquent and dropped from the rolls if renewal has not been received within *three months* after the first notice of expiration.

All funds collected by Friends of the Garden go directly to the support of the MISSOURI BOTANICAL GARDEN, and contributions are deductible for income tax purposes in the manner and to the extent provided by law.

Checks should be made payable to:

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This coupon is supplied for persons interested in new memberships. Current members will be billed for dues on the anniversary of their membership.

ADDENDUM

MISSOURI BOTANICAL GARDEN BULLETIN

VOL. XLIX NO. 10 DECEMBER, 1961

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SOME FACTS ABOUT SHAW'S GARDEN

The Missouri Botanical (Shaw's) Garden was established in 1859 by Henry Shaw, a St. Louis businessman, to be controlled by a Board of Trustees for the public benefit. The Garden is a non-profit institution which receives no support from the city or state, depending on the income from the Shaw estate supplemented by contributions from the public.

The old stone walls and cast-iron fences, the Linnean House, the Museum Building, the part of the Administration Building which was Shaw's Town House, relocated in the Garden in 1890, and the Tower Grove House, his country home, all date from Mr. Shaw's time. The Main Gate, display and growing greenhouses and most other facilities date from the period immediately following the turn of the century. The Climatron, opened in 1960, is the first of several new buildings planned for the Garden's redevelopment. It is the world's first geodesic dome, fully climate-controlled greenhouse and contains the Garden's tropical collections.

The Garden—70 acres—is open every day of the year from 9:00 A. M. until sundown; the greenhouses 9:00 A. M. to 5:00 P. M.; the Climatron Monday through Thursday 9:00 A. M. to 6:00 P. M., Friday through Sunday 9:00 A. M. to 10:00 P. M. Tower Grove House is open daily from 9:00 A.M. to 5:00 P.M. (April through November); 10:00 A.M. to 4:00 P.M. (December through March). The Display House presents four seasonal displays: November, Chrysanthemums; December, Poinsettias; February, Orchids; Spring, Lilies and other flowers. During the year are other shows, competitions and festivals sponsored by various Garden Clubs and Flower Societies.

Courses in Botany and Horticulture for adults are conducted by the Garden staff. Children's nature studies are provided each Saturday of the year and a special nature program is held during the summer. Information on these activities is published in the BULLETIN or may be had by mail or phone. The Garden maintains a research program through the Henry Shaw School of Botany, Washington University.

In 1926 an Arboretum — 1600 acres — was established at Gray Summit, Missouri. Foot trails and roads pass through the Arboretum and are open to visitors in April and May.

The Garden Administration Building is located at 2315 Tower Grove Ave., and the Garden main entrance is at Tower Grove and Flora Place. The entrance at Tower Grove and Cleveland Avenue is also open to the public. The Garden is served by both the Sarah (No. 42) and the Park-Southampton (No. 80) city bus lines.

Persons interested in helping to support the Garden and taking part in Garden activities are urged to do so through the "Friends of the Garden". Information may be obtained from the Main Gate or by mail or phone.